**Summary of 2017 Juvenile Fish Bypass Operations at Wells Hydroelectric Project**
**December 28, 2017**

Douglas PUD operated the Wells bypass system in 2017 as guided by the Wells HCP Coordinating Committee-approved *2017 Bypass Operating Plan.* The plan was intended to provide non-turbine passage during 95 percent of the juvenile Plan Species migration passing Wells Dam. Bypass operations were initiated on April 9 at 00:00 hours, and operated continuously until terminated at 24:00 hours on August 19, for a total of 133 days.

The *2017 Bypass Operating Plan* included measures for complying with Federal Energy Regulatory Commission (FERC) requirements for maintaining minimum automatic-gate-opening capacity under the *Wells Project Emergency Action Plan* (EAP) and Washington Department of Ecology requirements for compliance with total dissolved gas (TDG) standards as directed by the FERC-approved *Total Dissolved Gas Abatement Plan* (GAP) for the Wells Project. Compliance with the requirements of both of these plans is typically achieved by systematic removal of bypass barriers under increasing discharge, including the concentration of spill through adjacent spillways at the center of Wells Dam and spilling over the discharge from active turbine units, as described in the *2017 Bypass Operating Plan*.

With an early freshet beginning in mid-March and persisting into the third week of April, the bypass barriers for spillways 6 and 8 were not installed at the start of bypass season because flow and involuntary spill volumes already met the criteria for barrier removal. As flows and spill diminished in the third week of April, the barriers were installed in Spillway 8 (April 19) and Spillway 6 (April 25). Criteria for removal of bypass barriers were again met in early May, and the barriers for Spillway 6 were removed on May 6 and were not reinstalled until July 3. The barriers for Spillway 4 were removed on July 5 to allow removal of the bulkheads from the intake slots of Turbine Unit 4 and installation of the trash racks, in order to return Unit 4 to service after an extended outage. The bypass barriers for Spillway 4 were reinstalled on July 12.

Based on analysis conducted by Drs. John Skalski and Richard Townsend of Columbia Basin Research (Appendix A), Douglas PUD achieved the HCP requirement to provide bypass operations during 95 percent of the juvenile salmon and steelhead migration passing Wells Dam, providing bypass passage during 99.85 percent of the yearling Chinook migration, 100 percent of the steelhead migration, 99.99 percent of the Sockeye migration, 100 percent of the Coho migration, and 99.70 percent of the sub-yearling Chinook migration passing Wells Dam in 2017.

# Appendix A

## Analysis of Proportion of Outmigration Affected by Bypass Operations at Wells Dam in 2017

# Analysis of Proportion of Outmigration Affected by Bypass Operations at Wells Dam in 2017

Prepared for:

Tom Kahler
Public Utility District No. 1 of Douglas County
1151 Valley Mall Parkway
East Wenatchee, Washington 98802 - 4497

Prepared by:

John R. Skalski
Richard L. Townsend

Columbia Basin Research
School of Aquatic and Fishery Sciences
University of Washington
1515 Fourth Avenue, Suite 1515
Seattle, Washington 98101-2540

13 December 2017

# 1. Introduction

This analysis summarizes the outmigration timing that has been monitored at the juvenile sampling facility at Rocky Reach Dam or detected at the Rocky Reach Bypass PIT-tag detector for five stocks of salmonids (Coho salmon, yearling and subyearling Chinook salmon, steelhead, and sockeye salmon) for the period 2012-2017. The proportions of each stock covered by the bypass operations at Wells Dam can be estimated using daily counts at Rocky Reach Dam, adjusting for the travel time from Wells to Rocky Reach dams. Table 1 has the average travel times based on Douglas PUD's 2010 PIT-tag study for yearling Chinook salmon, and acoustic-tag studies for steelhead and sockeye salmon. Since there are no PIT-tag or acoustic-tag studies measuring travel times of subyearling Chinook, travel time was assumed to be 5 days, which is approximately one-half of the median travel time (11 days) to Rocky Reach Dam of PIT-tagged wild subyearling Chinook released at the mouth of the Okanogan River in 2017. Coho travel time was assumed to match that of yearling Chinook, and preliminary PIT-tag data appears to validate this assumption (Appendix, Table A1).

Table 1: Average travel times from Wells tailrace to Rocky Reach Dam, based on study results or assumptions of similarity to surrogate species.

| Stock | Travel time |
|---|---|
| Yearling Chinook salmon | 5 days |
| Subyearling Chinook salmon | 5 days |
| Steelhead | 2 days |
| Sockeye salmon | 2 days |
| Coho salmon | 5 days |

Plots of the annual cumulative proportion of the outmigration for spring migrants (yearling Chinook, steelhead, sockeye, and coho salmon), and subyearling Chinook salmon in the summer have fairly consistent start and end dates across years at Rocky Reach Dam (Figure 1). The timing of bypass operations at Wells Dam from 2012 through 2017 was from 00:00 April 9$^{th}$ through 24:00 on August 19$^{th}$. This current timing of bypass operations will continue annually, unless modified as a result of future investigations that demonstrate an inadequacy of these dates at providing bypass passage for ≥95% of the migrations of both spring- and summer-migrating Plan Species at Wells Dam.

# 2. Results

## 2.1 Bypass coverage, 2012–2017

For each Plan Species, the proportions of migrations that passed during the Wells bypass operations in 2017 were 99.85% for yearling Chinook salmon (combined hatchery and wild), 100% for steelhead, 99.99% for sockeye salmon, 100% for coho salmon, and 99.70% for subyearling Chinook salmon (combined hatchery and wild). The 2017 results for all monitored Plan Species were consistent with historical trends, 2012–2017 (Table 2).

At the Wells HCP Coordinating Committee's (CC) request, the run timing of the wild component of the yearling and subyearling Chinook populations was also analyzed independent of the hatchery populations. Table 2 shows the annual estimated proportion of Plan Species, by run component, passing Wells Dam. Tables 3 and 4 contain the results of this comparison

To assess the effectiveness of the selected start date for bypass operations, Table 3 compares the start date for bypass operations each year with the date on which the 5$^{th}$ percentile of the cumulative yearling Chinook salmon outmigration passed Wells Dam that year. For yearling Chinook salmon (combined hatchery and wild) in 2017, the start date for bypass operations was 8 days earlier than necessary to achieve the HCP standard of providing bypass passage for ≥95% of the migration. However, for wild only, the start date for bypass operations was 3 days later than necessary (see Section 2.2).

Similarly, Table 4 compares the actual termination date for bypass operations with the date on which bypass operations covered 95% of the subyearling Chinook salmon outmigration. In each year, an earlier termination of bypass operations would have been possible without jeopardizing the achievement of the HCP standard of providing a bypass route for ≥95% of outmigrating subyearling Chinook salmon. For combined hatchery and wild subyearling Chinook salmon in 2017, the termination of bypass operations at midnight on August 19 was 13 days later than required to achieve the HCP standard of providing bypass passage for ≥95% of the migration.

Table 2. Total proportion of each population of Plan Species in relation to bypass operations at Wells Dam, based on travel times from Wells Dam to Rocky Reach Dam, the cumulative proportion of the annual migration of each stock at Rocky Reach, and the start and stop dates of Wells bypass operations, 2012-2017. Supplemental information on hatchery and wild-origin PIT-tagged releases above Wells Dam were also included for both yearling and subyearling Chinook for the years 2012-2017.

| | Proportion passed | Annual migration proportion | | | | | |
|---|---|---|---|---|---|---|---|
| Spring Outmigration | **Yearling Chinook Salmon+** | | | | | | |
| | ***Hatchery & Wild:*** | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| | prior to Bypass Ops period | 0.0022 | 0.0026 | 0.0055 | 0.0026 | 0.0032 | **0.0017** |
| | **during Bypass Ops period** | **0.9978** | **0.9974** | **0.9945** | **0.9974** | **0.9968** | **0.9983** |
| | after Bypass Ops period | 0 | 0 | 0 | 0 | 0 | **0** |
| | ***Wild Only:*** | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| | prior to Bypass Ops period | 0.0438 | 0.1386 | 0.1823 | 0.1402 | 0.1897 | **0.0708** |
| | **during Bypass Ops period** | **0.9562** | **0.8614** | **0.8177** | **0.8598** | **0.8103** | **0.9292** |
| | after Bypass Ops period | 0 | 0 | 0 | 0 | 0 | **0** |
| | **Steelhead** | | | | | | |
| | | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| | prior to Bypass Ops period | 0.0014 | 0.0079 | 0.0021 | 0.0029 | 0.0022 | **0** |
| | **during Bypass Ops period** | **0.9986** | **0.9921** | **0.9975** | **0.9969** | **0.9977** | **1.0000** |
| | after Bypass Ops period | 0 | 0 | 0.0004 | 0.0002 | 0.0001 | **0** |
| | **Sockeye Salmon** | | | | | | |
| | | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| | prior to Bypass Ops period | 0 | 0 | 0 | 0 | 0 | **0** |
| | **during Bypass Ops period** | **1.0000** | **0.9999** | **0.9999** | **1.0000** | **1.0000** | **0.9999** |
| | after Bypass Ops period | 0 | 0.0001 | 0 | 0.0001 | 0 | **0** |
| | **Coho Salmon** | | | | | | |
| | | | 2013 | 2014 | 2015 | 2016 | **2017** |
| | prior to Bypass Ops period | | 0.0001 | 0.0001 | 0.0004 | 0.0024 | **0** |
| | **during Bypass Ops period** | | **0.9999** | **0.9999** | **0.9996** | **0.9976** | **1.0000** |
| | after Bypass Ops period | | 0 | 0 | 0 | 0 | **0** |
| Summer Outmigration | **Subyearling Chinook Salmon+** | | | | | | |
| | ***Hatchery & Wild:*** | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| | prior to Bypass Ops period | 0 | 0 | 0 | 0 | 0 | **0** |
| | **during Bypass Ops period** | **0.9639** | **0.9885** | **0.9611** | **1.0000** | **1.0000** | **0.9970** |
| | after Bypass Ops period | 0.0361 | 0.0115 | 0.0389 | 0 | 0 | **0.0030** |
| | ***Wild Only:*** | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| | prior to Bypass Ops period | 0 | 0 | 0 | 0 | 0 | **0** |
| | **during Bypass Ops period** | **0.9639** | **0.9885** | **0.9611** | **1.0000** | **1.0000** | **0.9957** |
| | after Bypass Ops period | 0.0361 | 0.0115 | 0.0389 | 0 | 0 | **0.0043** |

**+Proportion estimated using only PIT-tagged releases above Wells Dam.**

Table 3. A comparison of the actual start date for bypass operations at Wells Dam for the last 10 years versus the date on which the 5th percentile of the PIT-tagged yearling Chinook salmon migration passed Wells Dam that year, 2012-2017. Operations begin at 00:01 for the date listed in column 2. "Proportion bypass operations would have covered" indicates the proportion of the migration that would have been provided a bypass passage route had bypass operations started at 00:01 on the date that the 5th percentile of the migration passed Wells Dam (column 5). "Bypass start date timing" (column 8) indicates whether the bypass start date was before or after the date on which the 5th percentile of the yearling Chinook migration passed Wells Dam, and by how many days. Wild Only passage dates shown for reference.

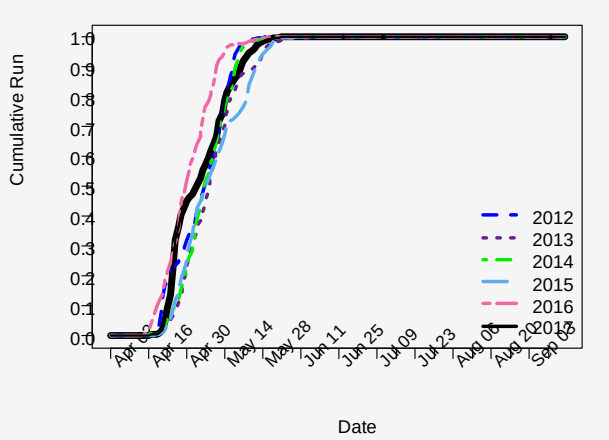
| Migration Year | Actual bypass start date | Cumulative proportion passed before 00:01 | Proportion Covered by Bypass Ops | Date on which the 5th percentile passed | Cumulative proportion passed before 00:01 | Proportion bypass ops. would have covered | Bypass start date timing |
|---|---|---|---|---|---|---|---|
| **Hatchery & Wild** | | | | | | | |
| 2012 | April 9 | 0.0022 | 0.9978 | April 15 | 0.0269 | 0.9731 | 6 days before |
| 2013 | April 9 | 0.0026 | 0.9974 | April 18 | 0.0405 | 0.9595 | 9 days before |
| 2014 | April 9 | 0.0055 | 0.9945 | April 17 | 0.0277 | 0.9723 | 8 days before |
| 2015 | April 9 | 0.0026 | 0.9974 | April 18 | 0.0381 | 0.9219 | 9 days before |
| 2016 | April 9 | 0.0032 | 0.9968 | April 12 | 0.0410 | 0.9590 | 3 days before |
| 2017 | April 9 | 0.0017 | 0.9983 | April 17 | 0.0493 | 0.9507 | 8 days before |
| **Wild Only** | | | | | | | |
| 2012 | April 9 | 0.0438 | 0.9562 | April 10 | 0.0438 | 0.9562 | 1 day before |
| 2013 | April 9 | 0.1386 | 0.8614 | April 4 | 0.0301 | 0.9699 | 5 days after |
| 2014 | April 9 | 0.1823 | 0.8177 | April 5 | 0.0331 | 0.9669 | 4 days after |
| 2015 | April 9 | 0.1402 | 0.8598 | April 2 | 0.0343 | 0.9657 | 7 days after |
| 2016 | April 9 | 0.1897 | 0.8103 | April 2 | 0.0460 | 0.9540 | 7 days after |
| 2017 | April 9 | 0.0708 | 0.9292 | April 6 | 0.0425 | 0.9575 | 3 days after |

Table 4. Comparison of the actual stop date for bypass operations at Wells Dam for the last 6 years, versus the stop date necessary to have covered at least 95% of the subyearling Chinook salmon outmigration that year (operations end at 24:00). In each year, bypass ended well after the dates on which standards were achieved. Wild Only passage dates shown for reference.

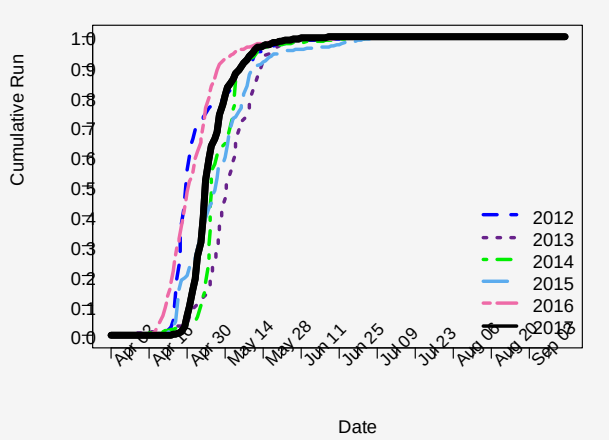
| Migration Year | Actual bypass stop date | Cumulative proportion passed by 24:00 of actual stop date | Date on which the 95% standard was achieved | Cumulative proportion passed by 24:00 of the date on which the 95% standard was achieved | bypass end date timing |
|---|---|---|---|---|---|
| **Hatchery & Wild** | | | | | |
| 2012 | August 19 | 0.9639 | August 16 | 0.9518 | 3 days after |
| 2013 | August 19 | 0.9885 | August 11 | 0.9515 | 8 days after |
| 2014 | August 19 | 0.9611 | August 18 | 0.9555 | 1 day after |
| 2015 | August 19 | 1.0000 | July 27 | 0.9506 | 23 days after |
| 2016 | August 19 | 1.0000 | July 20 | 0.9531 | 30 days after |
| 2017 | August 19 | 0.9970 | August 3 | 0.9533 | 16 days after |
| **Wild Only** | | | | | |
| 2012 | August 19 | 0.9639 | August 16 | 0.9518 | 3 days after |
| 2013 | August 19 | 0.9885 | August 11 | 0.9515 | 8 days after |
| 2014 | August 19 | 0.9611 | August 18 | 0.9555 | 1 day after |
| 2015 | August 19 | 1.0000 | August 1 | 0.9515 | 18 days after |
| 2016 | August 19 | 1.0000 | July 24 | 0.9547 | 26 days after |
| 2017 | August 19 | 0.9957 | August 5 | 0.9543 | 14 days after |

Figure 1. Passage distributions at Rocky Reach Dam juvenile collection facility for spring and summer migrating stocks, 2012-2017. Cumulative proportions are based on the expanded counts obtained from daily sampling at Rocky Reach from 1 April – 31 August, except where PIT-tagged releases above Wells Dam were available (wild and hatchery yearling and subyearling Chinook).

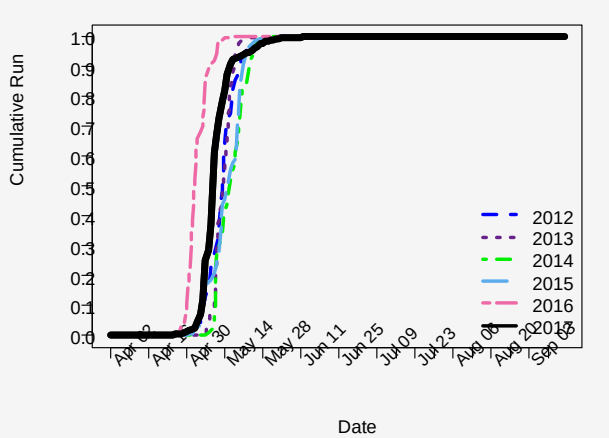
a. Yearling Chinook Salmon



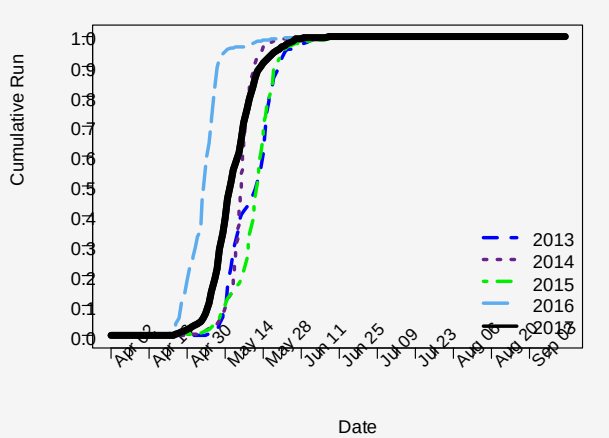

b. Steelhead



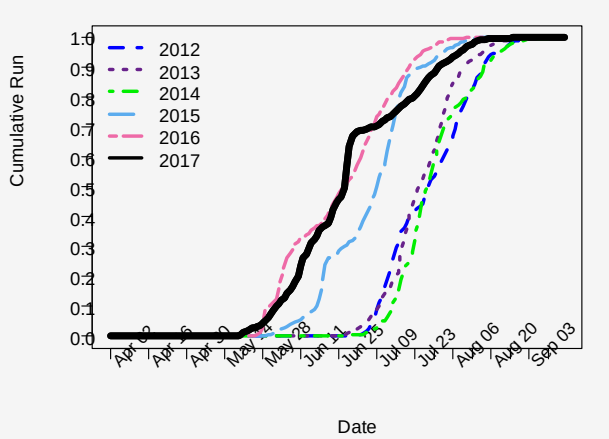

c. Sockeye Salmon




d. Coho Salmon




e. Subyearling Chinook Salmon



## 2.2 Comparing Migration Timing and Passage Proportions of PIT-tagged Hatchery and Wild-origin Yearling Chinook Released above Wells Dam

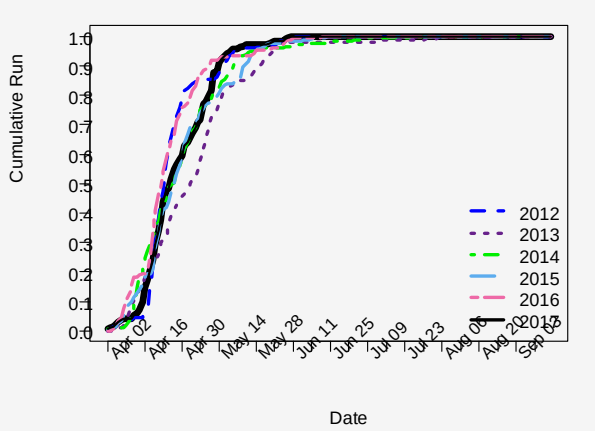
The yearling Chinook migration timing at Wells Dam was estimated using 1) the unadjusted daily counts of PIT-tagged fish released above Wells Dam; and 2) the unadjusted daily counts of PIT-tagged wild-origin fish released above Wells Dam (Table 5). For the six years used in the comparison of migration timing between PIT-tagged hatchery and wild-origin yearling Chinook released above Wells Dam, wild PIT-tagged yearling Chinook salmon appear to emigrate up to two weeks earlier than the hatchery-released yearling Chinook salmon (Figure 2).

Table 5. Total detections of yearling Chinook salmon at Rocky Reach Dam by year and group.

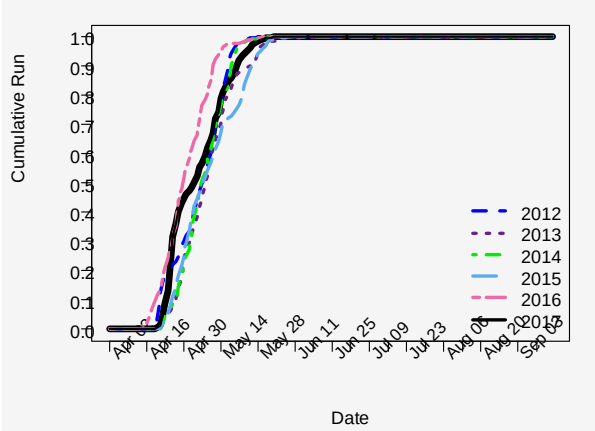
| Group | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Hatchery, Wild and Unknown PITs | 3,539 | 9,439 | 5,850 | 16,793 | 11,810 | 10,370 |
| Wild only PITs | 137 | 166 | 181 | 321 | 174 | 212 |

Figure 2. Comparison of Yearling Chinook migration timing at Wells Dam by rearing source a) wild origin only, b) hatchery only, and c) hatchery and wild origin.

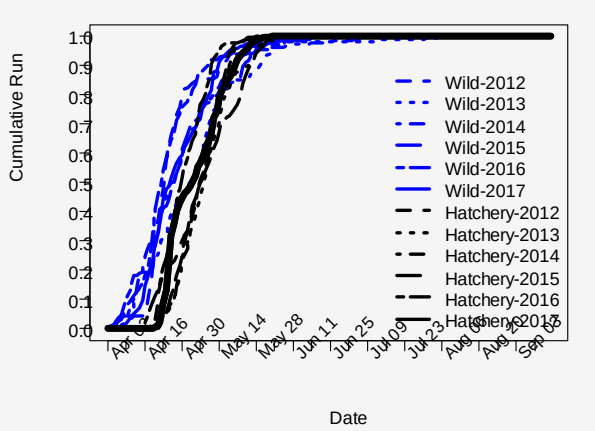
a. Wild only




b. Hatchery only




c. Comparison of Wild to Hatchery



With the observed differences in the passage timing of the hatchery and wild yearling Chinook salmon, bypass operations were apparently not equally effective in covering the wild and hatchery components of the yearling Chinook migration but were effective at achieving the HCP goal of covering ≥95% of a Plan Species migration (yearling Chinook hatchery and wild combined) (see Table 2). Bypass operations conveyed 99.9% to 100% of hatchery yearling Chinook salmon migrations in 2012–2017 (Table 6) and averaged 99.7% for the entire yearling Chinook (Plan Species) migration in 2012-2017 (see Table 2). In contrast, over the past six years 81.03% to 95.62% of the wild PIT-tagged yearling Chinook salmon migrations passed the project during bypass operations.

Table 6. Comparison of migration timing of PIT-tagged hatchery and wild-origin yearling Chinook released above Wells Dam.

| **Proportion passed** | | | | | | |
|---|---|---|---|---|---|---|
| ***Hatchery:*** | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| prior to Bypass Ops period | 0.0006 | 0.0002 | 0 | 0 | 0.0004 | **0.0003** |
| during Bypass Ops period | **0.9994** | **0.9998** | **0.9998** | **0.9999** | **0.9996** | **0.9997** |
| after Bypass Ops period | 0 | 0 | 0 | 0 | 0 | **0** |
| | | | | | | |
| ***Wild:*** | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| prior to Bypass Ops period | 0.0438 | 0.1386 | 0.1823 | 0.1402 | 0.1897 | **0.0708** |
| during Bypass Ops period | **0.9562** | **0.8614** | **0.8177** | **0.8598** | **0.8103** | **0.9292** |
| after Bypass Ops period | 0 | 0 | 0 | 0 | 0 | **0** |

## 2.3 Comparing Migration Timing and Passage Proportions of PIT-tagged Hatchery and Wild-origin Subyearling Chinook Released above Wells Dam

The subyearling Chinook migration timing at Wells Dam was estimated using 1) the unadjusted daily counts of PIT-tagged hatchery and wild fish released above Wells Dam; and 2) the unadjusted daily counts of PIT-tagged wild-origin fish released above Wells Dam. Each has the same caveats as the yearling Chinook salmon in regard to comparative migration sizes (Table 7). For the three years (2015–2017) that comparison of migration timing between PIT-tagged hatchery and wild-origin subyearling Chinook released above Wells Dam is possible, wild PIT-tagged subyearling Chinook salmon appear to emigrate up to a month later than the hatchery-released subyearling Chinook salmon (Figure 3).

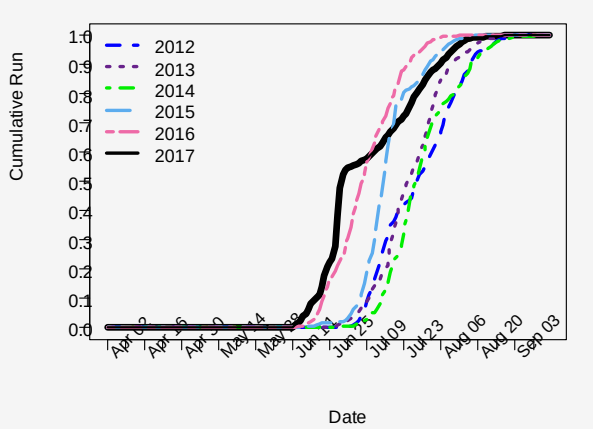
Despite differences in the passage timing of hatchery and wild subyearling Chinook salmon, bypass operations were effective in covering ≥95% of both components of the outmigration and for the outmigration as a whole (Table 8). Bypass operations covered 100% of the hatchery subyearling Chinook salmon in 2015–2017, and from 96.11% to 100% for PIT-tagged wild subyearling Chinook salmon. Therefore the timing of the bypass operations at Wells Dam is robust, conveying ≥95% of all components, individually and combined, of the subyearling Chinook salmon outmigration.

Table 7. Total detections of subyearling Chinook salmon at Rocky Reach Dam by year and group.

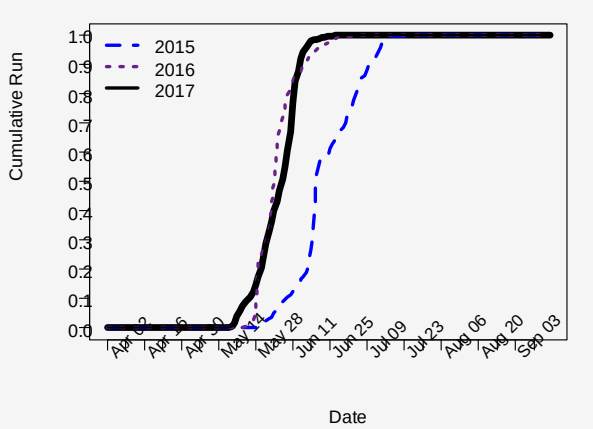
| Group | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Hatchery, Wild and Unknown PITs | 913 | 1,998 | 899 | 1,052 | 2,303 | 5,308 |
| Wild only PITs | 913 | 1,998 | 899 | 577 | 1,413 | 3,701 |

Figure 3. Comparison of Subyearling Chinook migration timing at Wells Dam by population component a) wild origin only, b) hatchery only, and c) hatchery and wild origin.

d. Wild only




e. Hatchery only




f. Comparison of Wild to Hatchery

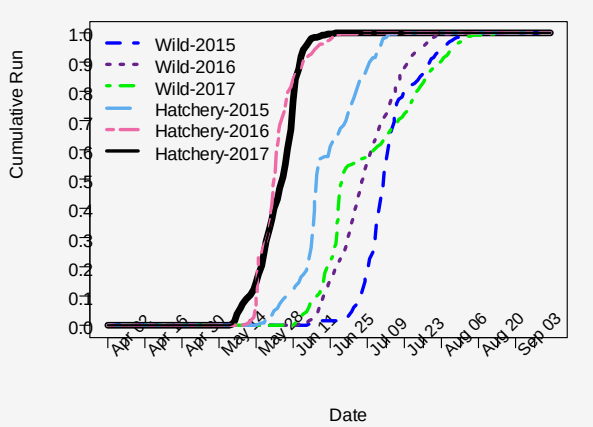


Table 8. Comparison of migration timing of PIT-tagged hatchery and wild-origin subyearling Chinook released above Wells Dam. PIT-tagged hatchery releases started in 2015.

| **Proportion passed** | | | | | | |
|---|---|---|---|---|---|---|
| ***Hatchery:*** | | | | 2015 | 2016 | **2017** |
| prior to Bypass Ops period | | | | 0 | 0 | **0** |
| during Bypass Ops period | | | | **1.0000** | **1.0000** | **1.0000** |
| after Bypass Ops period | | | | 0 | 0 | **0** |
| ***Wild:*** | 2012 | 2013 | 2014 | 2015 | 2016 | **2017** |
| prior to Bypass Ops period | 0 | 0 | 0 | 0 | 0 | **0** |
| during Bypass Ops period | **0.9639** | **0.9885** | **0.9611** | **1.0000** | **1.0000** | **0.9957** |
| after Bypass Ops period | 0.0361 | 0.0115 | 0.0389 | 0 | 0 | **0.0043** |

# 3. Discussion

In 2017, bypass operations covered between 99.70% and 100% of the outmigrations of the five Plan Species at Wells Dam, consistent with the requirements of the Wells HCP. The coverage rates achieved in 2017 are typical of past performance in 2012-2016 (see Table 2). At the HCP CC's request, the run timing of PIT-tagged wild and hatchery subyearling Chinook (i.e. 2015-2017) and hatchery and wild yearling Chinook (i.e. 2012-2017) salmon, were examined separately (Tables 6 & 8). The April 9 start date for bypass operations succeeded in providing bypass operations for ≥95% of the migration of combined wild and hatchery PIT-tagged yearling Chinook in every year since 2012. Evaluation of the migrations of the wild components of the Chinook outmigrations 2012-2017 revealed that there are differences between the wild and hatchery components of the yearling Chinook population with wild fish apparently migrating earlier than hatchery fish (see Figure 2 and Table 3) and earlier than observed in the historical hydroacoustic and fyke-netting data (Bickford 2003). These timing differences appear to increase the proportions of wild fish passing Wells before the start of bypass operations relative to the proportions of hatchery fish (see Table 2). Several differences between the yearling tag groups used in this comparison complicate definitive inferences from the analysis, and warrant further investigation. Those differences include stock composition, as the hatchery component comprises similar numbers of spring and summer Chinook, while the wild component is nearly entirely spring Chinook; sample size (see Table 5), where the small sample size of the wild component attributes greater relative weight to each individual detected; and, finally the shape of the detection-date distributions of each component.

For subyearling Chinook, the end date for bypass operations in 2017 succeeded in providing bypass operations for ≥95% of the migration of both wild and hatchery emigrants. Expanding the evaluation of wild Chinook emigrants to past years showed that the bypass termination date, in use since 2012, was adequate for providing bypass operations for ≥95% of the migration of both hatchery and wild subyearling Chinook.

# 4. Summary

For the sixth year in row, the Wells bypass operating dates of April 9th through August 19th achieved the HCP-required coverage for ≥95% of the migration for all five Plan Species. The wild component of yearling Chinook population appears to be migrating earlier than hatchery yearling Chinook and earlier than observed in the historical hydroacoustic and fyke-netting data. This difference in migration timing warrants further investigation toward ensuring that ≥95% of the yearling Chinook population continues to receive the required levels of protection in future years.

# 5. References

Bickford, S. 2003. Historical Hydroacoustic Information for Wells Dam, 1982 to 2002, and a Proposal for Future Operation of the Wells Bypass System. March 10, 2003. *Prepared for* Wells Coordinating Committee, *By* Public Utility District No. 1 of Douglas County, East Wenatchee, WA. 9 p., plus appendices.

# 6. Appendix

## *Using Wells Dam PIT-tag Detections*

2017 was the second year with available PIT-tag detections at Wells Dam (WEJ), with 269 unique tag codes identified. These comprised 114 Chinook salmon, 27 Coho salmon, 127 steelhead, and 1 sockeye salmon. As these numbers are too few to estimate any credible survival estimates, Table A1 summarizes the number of detections and estimated travel times between Wells and Rocky Reach Dam. It is hoped that future runs will be detected at higher numbers to enable a more detailed correction to the outmigration distribution estimated for Wells Dam. Results suggest the values in Table 1 are reasonable adjustments for travel time.

Table A1. Travel time summary for detected PIT-tagged fish at both Wells and Rocky Reach PIT-tag detectors in 2017.

| | | | Travel Time (days) | |
|---|---|---|---|---|
| Run Species | Detected at Wells Dam | Detected at Rocky Reach Dam | Mean (SE) | Range |
| Yearling Chinook | 114 | 21 | 6.7 (1.8) | 1.3 – 29.0 |
| Coho | 27 | 11 | 5.4 (0.8) | 2.2 - 10.0 |
| Steelhead | 127 | 41 | 1.9 (0.2) | 0.8 - 6.6 |
| Sockeye | 1 | 0 | | |