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MEMORANDUM

TO: Emi Kondo, NOAA

FROM: Michele DeHart

DATE: July 31, 2017

RE: Juvenile survival and travel time for Priest Rapids and Ringold Springs hatchery fall Chinook

In response to your request, The Fish Passage Center (FPC) is providing estimates of juvenile survival and travel time for hatchery fall Chinook smolts from Priest Rapids and Ringold Springs hatcheries. Specifically, you requested the FPC to estimate juvenile survival and travel time from release at the hatchery to Bonneville Dam. For Priest Rapids Hatchery, we limited these analyses to migration years 2012-2017, as these were years of large PIT-tag releases (~43,000 tags per year). PIT-tagging efforts have been more limited at Ringold Springs Hatchery. Therefore, we included all years of available tagging from this site (1996-2002 and 2016-2017).

Travel Time

For this portion of the request, we estimated separate minimum, median, and maximum fish travel times from release to detection at McNary Dam (Rel-MCN), release to detection at John Day Dam (Rel-JDA), and release to detection at Bonneville Dam (Rel-BON). This was done for each of the two hatcheries and each migration year. In addition, we provide estimates of the 95% confidence limits around these estimated median travel times.

PIT-tag release numbers, and subsequent downstream detections, for Priest Rapids Hatchery were sufficiently large to generate estimates of fish travel time (and 95% confidence intervals) for each of the three reaches (Rel-MCN, Rel-JDA, and Rel-BON) (Table 1). We attempted to do the same for the Ringold Springs Hatchery group but lower

PIT-tag release numbers and fewer detections made this difficult for some sites in some years (Table 2).

Table 1. Priest Rapids Hatchery subyearling fall Chinook travel times from release to McNary Dam, release to John Day Dam, and release to Bonneville Dam for migration years 2012-2017.

Travel Time Reach	Migration Year	Number Detected	Travel Time (Days)			95% Confidence Limits	
			Min	Med	Max	Lower	Upper
Rel-MCN	2012	3,034	2.2	17.8	41.2	17.4	18.0
	2013	4,925	3.4	17.5	43.9	17.3	17.8
	2014	6,436	0.0	12.5	47.9	12.3	12.6
	2015	2,720	3.7	12.1	95.3	11.9	12.3
	2016	4,128	2.3	6.2	147.1	6.0	6.3
	2017*	2,839	3.2	14.9	47.7	14.7	15.3
Rel-JDA	2012	4,078	6.3	20.4	58.8	20.1	20.5
	2013	2,589	6.3	19.2	54.4	19.0	19.4
	2014	2,722	0.5	16.8	61.8	16.6	17.1
	2015	2,028	7.6	16.6	142.0	16.4	16.8
	2016	1,912	5.3	9.8	93.8	9.7	10.0
	2017*	2,088	6.0	17.1	42.6	17.0	17.3
Rel-BON	2012	1,613	8.8	20.8	53.4	20.6	21.4
	2013	932	7.5	22.4	45.4	21.8	22.5
	2014	2,174	1.9	18.5	49.5	18.1	18.6
	2015	663	9.5	18.5	36.0	18.3	18.7
	2016	1,488	6.4	11.4	22.2	11.3	11.6
	2017*	3,019	9.3	19.0	47.4	18.8	19.3

* Travel times for 2017 should be considered preliminary, as these are based on juvenile detections through ~July 24, 2017. Future detections may cause this estimate to change.

Table 2. Ringold Springs Hatchery subyearling fall Chinook travel times from release to McNary Dam, release to John Day Dam, and release to Bonneville Dam for migration years 1996-2002 and 2016-2017.

Travel Time Reach	Migration Year	Number Detected	Travel Time (Days)			95% Confidence Limits	
			Min	Med	Max	Lower	Upper
Rel-MCN	1996	295	1.4	3.5	35.5	3.4	3.7
	1997	420	2.1	7.5	36.6	7.2	7.8
	1998	1,238	1.7	12.1	45.7	11.8	12.6
	1999	619	3.0	12.0	44.4	11.5	12.6
	2000	1,101	0.2	9.8	56.7	9.2	10.1
	2001	1,331	1.9	11.5	66.0	11.3	11.8
	2002	732	0.1	7.6	33.7	6.7	8.3
	2016	162	2.5	5.8	16.9	5.5	6.4
	2017	386	4.2	8.1	25.1	7.9	8.4
Rel-JDA	1996	2	6.1	6.5	6.9	N/A	N/A
	1997	0	N/A	N/A	N/A	N/A	N/A
	1998	150	7.2	20.9	48.8	20.1	21.8
	1999	476	5.3	12.6	60.6	12.5	13.3
	2000	128	5.0	16.4	46.5	12.9	17.7
	2001	457	11.6	38.1	88.3	36.9	39.1
	2002	337	2.0	11.6	35.1	10.4	13.5
	2016	86	5.2	8.4	93.8	7.8	9.0
	2017	201	7.5	11.1	26.8	10.9	11.6
Rel-BON	1996	3	8.5	9.4	16.4	N/A	N/A
	1997	106	8.2	12.6	31.6	12.5	12.7
	1998	35	9.7	22.1	67.0	19.4	22.7
	1999	275	7.5	17.0	49.0	16.5	18.1
	2000	15	8.0	13.2	27.1	11.1	18.3
	2001	73	15.2	30.7	79.5	27.8	37.5
	2002	277	3.2	13.4	37.8	11.4	14.4
	2016	59	7.2	9.4	22.4	8.8	10.4
	2017	243	8.0	13.3	29.1	12.6	13.5

* Travel times for 2017 should be considered preliminary, as these are based on juvenile detections through ~July 24, 2017. Future detections may cause this estimate to change.

Juvenile Survival

We also estimated juvenile survival for each hatchery, by migration year. The original request was to estimate survival from release to BON (Rel-BON). However, estimating survival to BON requires detections below BON, which can sometimes be difficult for summer migrants as the NOAA estuary trawl does not always operate later in the summer. With this in mind, we attempted to estimate survival from release to MCN (Rel-MCN), release to JDA (Rel-JDA), and release to BON (Rel-BON).

To estimate survival from Rel-BON, we developed a 5-digit capture history for each PIT-tagged fish. This 5-digit capture history included the following: 1) release, 2) detection at MCN, 3) detection at JDA, 4) detection at BON, and 5) detection at the estuary trawl. To estimate survival from Rel-JDA, we developed a 4-digit capture history, which included the following: 1) release, 2) detection at MCN, 3) detection at JDA, 4) detection at either BON or the estuary trawl. Using these capture histories, single mark-release mark-recapture survival estimates were generated using Cormack-Jolly-Seber (CJS) methodology, as described by Burnham et al. (1987) with program MARK (software available free from Colorado State University). (White and Burnham 1999). This

generated estimates of survival for each of the individual reaches: 1) Rel-MCN, 2) MCN-JDA, and 3) JDA-BON. These individual reach survivals were combined to estimate survival for combined reaches (Rel-JDA and Rel-BON). Variance estimates for the product of individual reach survivals were generated using the delta method (Burnham et al. 1987). Using this methodology, estimates of individual reach survival (e.g., Rel-MCN, MCN-JDA, or JDA-BON) can exceed 100%. However, individual reach estimates are often negatively correlated with adjacent reaches. Therefore, when estimating combined reach survivals (e.g., Rel-JDA and Rel-BON), we allow individual reach survival estimates to exceed 100%. A combined reach survival was considered unreliable when its point estimate exceeded 100% or its coefficient of variation exceeded 25%.

We were unable to obtain reliable estimates of survival from Rel-BON for the Priest Rapids Hatchery releases. However, we were able to obtain reliable estimates of survival from Rel-JDA and Rel-MCN for all six years (2012-2017) (Table 3). Estimating survival from Rel-BON was also not possible for the Ringold Springs Hatchery releases. We were only able to obtain reliable survival estimates for the Rel-JDA reach in four of the migration years (1999, 2001-2002, and 2017) (Table 4). Finally, we were able to obtain reliable estimates of survival for Ringold Spring Hatchery from the Rel-MCN reach in all but one migration year (Table 4).

Table 3. Priest Rapids Hatchery subyearling fall Chinook survivals for release to McNary Dam and release to John Day Dam, 2012-2017. Numbers in parentheses are the 95% confidence intervals.

Migration Year	Number of Tags Released	Release-MCN Survival	Release-JDA Survival
2012	42,844	0.61 (0.57-0.65)	0.55 (0.46-0.65)
2013	42,908	0.67 (0.62-0.71)	0.56 (0.45-0.67)
2014	43,103	0.63 (0.60-0.65)	0.42 (0.34-0.51)
2015	42,621	0.78 (0.67-0.86)	0.38 (0.23-0.54)
2016	42,955	0.85 (0.75-0.91)	0.29 (0.24-0.34)
2017*	42,964	0.53 (0.57-0.50)	0.40 (0.34-0.45)

* Survivals for 2017 should be considered preliminary, as these are based on juvenile detections through ~July 24, 2017. Future detections may cause this estimate to change.

Table 4. Ringold Springs Hatchery subyearling fall Chinook survivals for release to McNary Dam and release to John Day Dam, 2012-2017. Numbers in parentheses are the 95% confidence intervals.

Migration Year	Number of Tags Released	Release-MCN Survival	Release-JDA Survival
1996	1,486	N/A	N/A
1997	1,496	0.63 (0.30-0.96)	N/A
1998	2,993	0.75 (0.65-0.84)	N/A
1999	2,967	0.83 (0.72-0.91)	0.58 (0.53-0.64)
2000	3,102	0.55 (0.48-0.61)	N/A
2001	3,007	0.73 (0.68-0.78)	0.37 (0.27-0.48)
2002	2,995	0.70 (0.64-0.76)	0.49 (0.32-0.67)
2016	3,057	0.63 (0.30-0.96)	N/A
2017*	3,237	0.69 (0.54-0.81)	0.48 (0.27-0.69)

* Survivals for 2017 should be considered preliminary, as these are based on juvenile detections through ~July 24, 2017. Future detections may cause this estimate to change.

To put into context the conditions that these fall Chinook juveniles may have experienced during their out-migration, Figure 1 provides the summer flow volume (July 1-August 31) for the Middle Columbia River (as measured at Bonneville Dam), along with the average summer spill proportions at each of McNary, The Dalles, John Day, and Bonneville dams for each migration year.

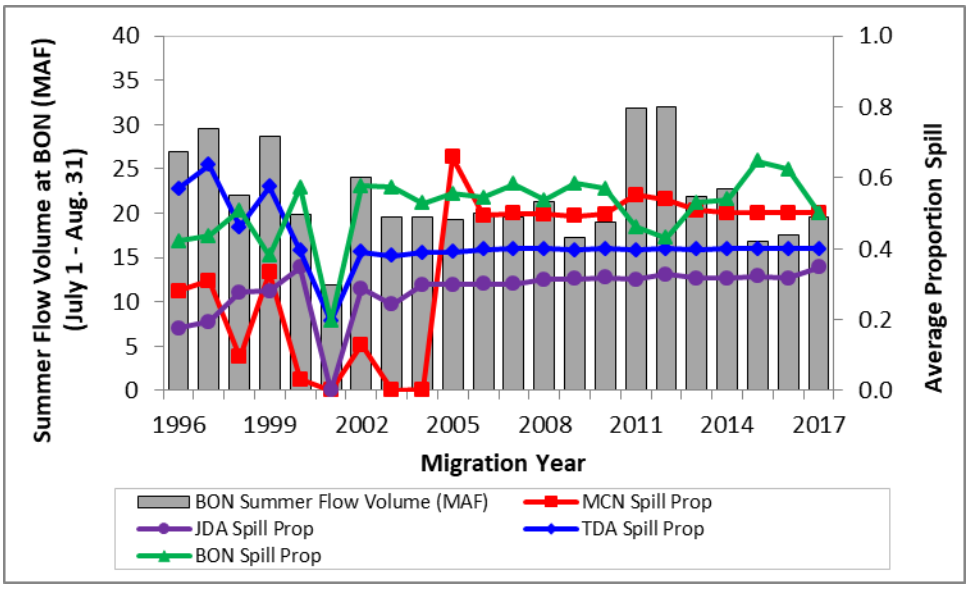

Figure 4. Summer flow volume (July 1–August 31) in the Middle Columbia River (at Bonneville Dam) and average spill proportion at McNary, John Day, The Dalles, and Bonneville dams, 1996-2016. Summer flow volume for 2017 is based on acutal flows through July 25, 2017 and predicted flows from July 26-August 31 based on the July 24, 2017 STP run. Average proportion spill for 2017 is based on data from July 1 to July 25, 2017.