DART Adult Reach Distribution and Delay Detailed Analysis

Memo for FPOM Task Group meeting on December 10, 2024
December 9, 2024

From: Susannah Iltis (siltis@uw.edu) and Jennifer L. Gosselin (gosselin@uw.edu)
Columbia River Data Access in Real Time (DART), Columbia Basin Research
School of Aquatic and Fishery Sciences, University of Washington

To: FPOM Task Group – Adult Fish Delay Criteria
Fish Passage Operation and Maintenance (FPOM)

Summary

- The Columbia River DART tool, **Adult Reach Distribution and Delay,** provides information on PIT-tagged adult Chinook salmon migrating upstream in the mainstem Columbia River and Snake River. It provides various in-season metrics of percent arrivals by reach.
- **Refinements to the DART tool are in progress** and additional refinements are possible. To help answer questions and fulfill requests from the FPOM Task Group on Adult Fish Delay Criteria, the present memo provides more detailed information than what is currently available on the website.
- To help assess the meaningfulness of reach travel times to a more ultimate outcome, exiting the hydroelectric power system at GRA, we provide figures and tables of the **% of fish exiting the hydrosystem (i.e., GRA)** by each reach (MCA-ICH, ICH-LMA, LMA-GOA, GOA-GRA) in each year (2016-2024). (Section 1.1)
- In addition to the figures and tables in section 1.1, analyses were run to estimate the **probability of individual fish exiting GRA** in association with reach travel time indicators and other covariates. The results showed that higher probabilities of exiting GRA were associated with shorter reach travel times (< 3 days vs ≥ 3 days; or <4 days vs ≥ 4 days). Also, the results from a reach travel time indicator with a 4-day cutpoint were very similar to results with a 3-day cutpoint. (Section 1.2)
- In 2016-2024, the 3-day adult delay trigger (or 3-day "dots") would have occurred more often with **3-day cohort** data than with **1-day cohort** data. There were a few occurrences in specific years and reaches when 3-day dots would have occurred more often with 3-day cohort data than 1-day cohort data. Furthermore, the **3-day dots** would have occurred more frequently than with the **4-day dots**, but not in all years and reaches. (Section 2)
- A new feature of **2-day Predicted Range** will be added to the DART tool. The methods and an example are provided, including explanations of **3-day and 1-day cohorts**. (Section 3)
- Decisions from the task group can inform how the DART tool can be refined early in the year of 2025.

Table of Contents

Background

The Columbia River DART tool, **Adult Reach Distribution and Delay** (hereafter referred to as the **DART tool**), was first developed in 2018 to provide information on adult Chinook salmon tagged with passive integrated transponder (PIT) tags showing various summary metrics (e.g., percent of 3-day cumulative cohort arriving to next upstream dam in less than 4 days) and in comparison to river conditions (spill percent and tailrace total dissolved gas) and adult visual counts.

The purpose of the **DART tool** (Figure 1a) is to report in real-time on reach travel time and highlight potential delay events in upstream migration for adult PIT-tagged Chinook salmon during the spring spill period (4/3 –6/20) at Lower Snake River reaches. Daily cohorts are created and tracked based on departure date from the dam at the downstream end of the reach of interest, and used to report reach travel time, percent arrival, percent 'in route' (i.e., not arrived yet, and could be due to a number of reasons, such as delay, fallback, wandering, harvest, and mortality from predation), as well as comparisons to visual counts (Figure 1b).

The percent of fish that arrive at a dam on the mainstem Snake River is calculated from PIT tagged Chinook salmon detections that departed the lower dam of a single reach (or multiple reaches) of interest. In this memo, we focus on single reaches, MCA-ICH, ICH-LMA, LMA-GOA, and GOA-GRA. Currently, the **DART tool** calculates cumulative arrival percents based on running 3-day cumulative cohort departures. For more information, see **Appendix 1. Data set details and additional information related to DART tool**.

Relatively recently (May 18, 2024), the **Single Departure Event per TagID** option was added to the **DART tool**. Even though the **Daily Cohort** option was originally developed to be most comparable to the visual counts because it would include any reascensions, a single departure event for each PIT-tagged salmon provides more pertinent information for management of adult salmon travel time and delay.

We aim to answer some questions and requests by the task group that was brought to our attention with the additional information we provide in this memo. Decisions from the task group on refining the adult trigger can be incorporated into the refinements of the **DART tool** that are already in progress and planned for release early next year.

For an overview of methods for the **DART tool** , see
https://www.cbr.washington.edu/dart/metadata/pitreach.

All data used in this memo are available for download from:
https://www.cbr.washington.edu/dart/cs/data/reachdist.zip

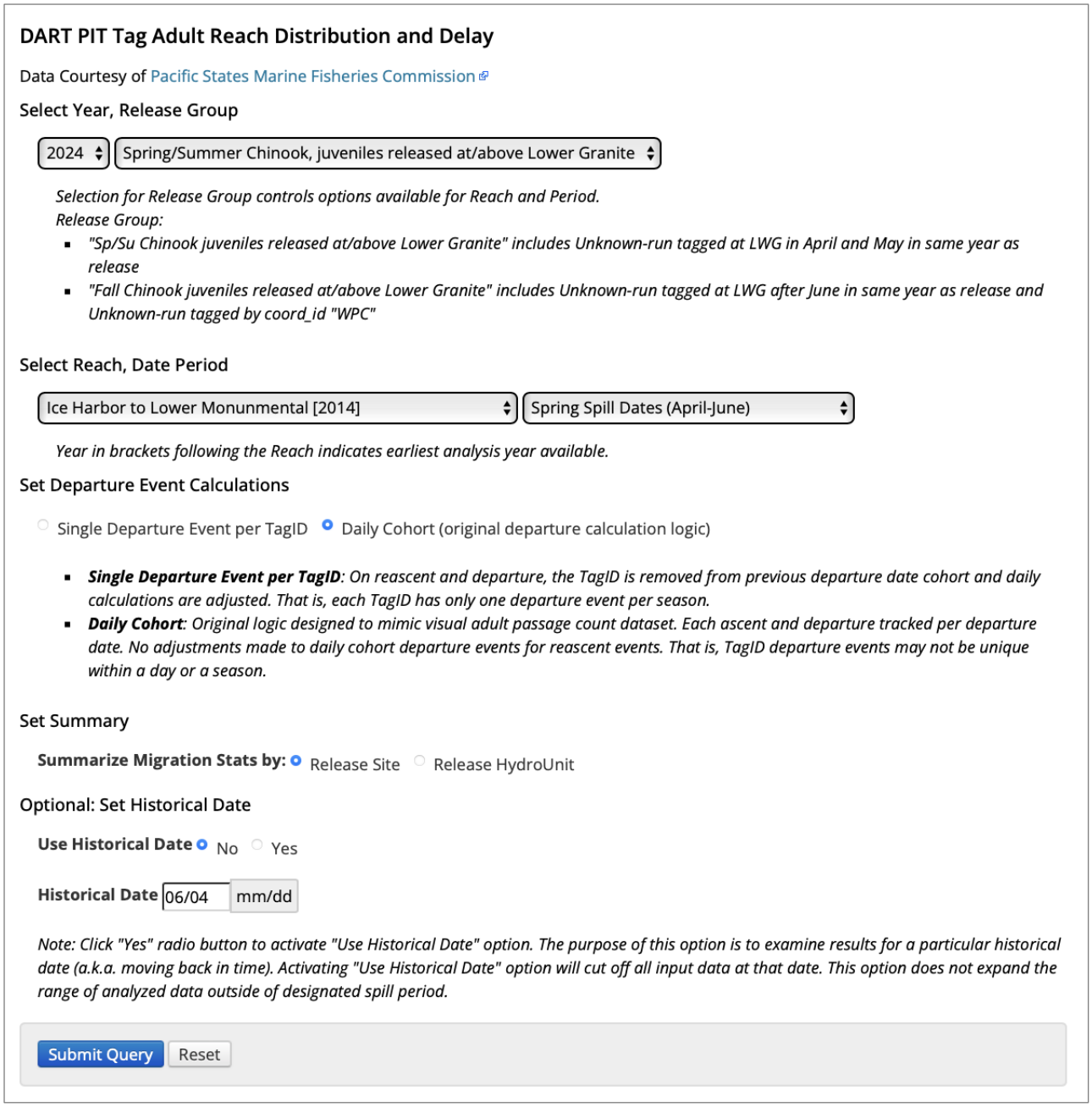


Figure 1a. Screenshot of existing input console of the DART tool.

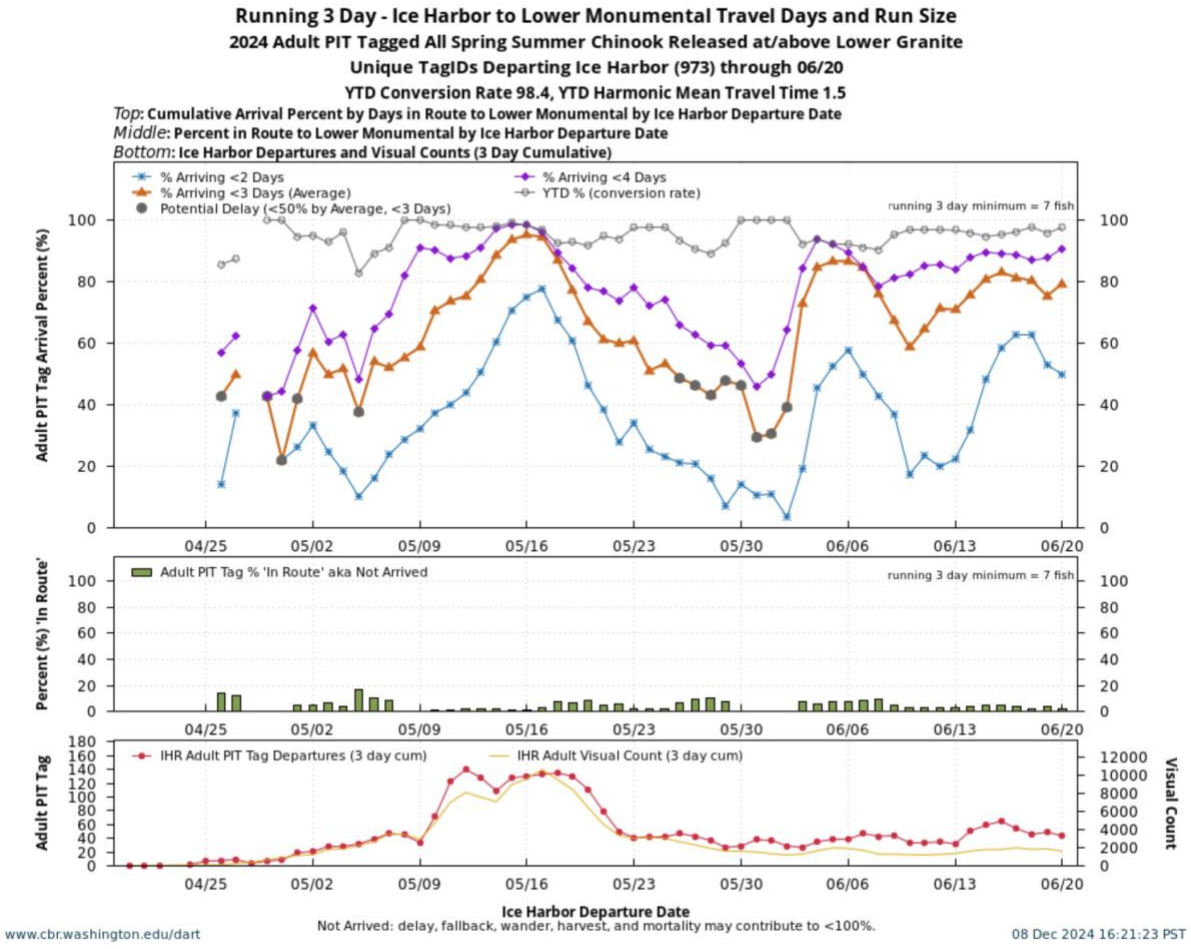


Figure 1b. Screenshot of an example output from the DART tool.

Questions, Results, and Interpretation

1. Probability of exiting the hydrosystem at GRA by reach travel times

Is the probability of exiting GRA associated with reach travel times?

1.1. Daily % conversions: figures comparing reach travel times < 3 d vs ≥ 3 d

Across the years from 2016-2024, the average percentages of salmon that exited GRA by each departed reach were:

- **MCN-ICH**: 88.2% ± SD 9.6%,
- **ICH-LMA**: 89.7% ± 10.0%,
- **LMA-GOA**: 90.4% ± 9.9%, and
- **GOA-GRA**: 92.0% ± 10.3%.

Not surprisingly, the average percentages of salmon exiting GRA declined as the distance from the departing reach increased.

Of the number of salmon that exited GRA in years 2016-2024, the average percentages of those that had reach travel times < 3 d and ≥ 3 days, were respectively, by each departure reach:

- **MCN-ICH**: 90.2% ± SD 9.8% for **< 3 days**; 86.4% ± SD 11.6% for **≥ 3 days**,
- **ICH-LMA**: 90.8% ± SD 9.5% for **< 3 days**; 86.9% ± SD 13.8% for **≥ 3 days**,
- **LMA-GOA**: 92.3% ± SD 10.1% for **< 3 days**; 91.8.4% ± SD 10.7% for **≥ 3 days**,
- **GOA-GRA**: 93.1% ± SD 10.1% for **< 3 days**; 93.5% ± SD 9.6% for **≥ 3 days**.

The percentages, out of the number of salmon that exited GRA, tended to be greater for salmon with reach travel times < 3 days than ≥ 3 days. For the percentages broken down by each year and each reach, see **Table 1 through Table 4**, and **Figure 2 through Figure 9**. For daily percentages through the seasons of 2016-2024, see **Appendix 2. Daily % conversions exiting GRA**.

Data sets for final outcomes (last detection, mortality, undetected) above GRA are readily available but are not included here as it would require additional analyses. The additional analyses would need to account for the network of detection arrays upstream of GRA and associated low levels of detections (Morrissett, Skalski, and Kiefer 2019).

Table 1. McNary to Ice Harbor Reach Statistics for PIT-tagged Spring/Summer Adult Chinook departing McNary during Spring Spill Period, April 3-June 20, 2016-2024

Total Population					
Year	Total Departed	Total Converted	Percent Converted	Total GRA Exit	**Percent GRA Exit**
2016	1299	1262	97.2	1149	**88.5**
2017	646	618	95.7	411	**63.6**
2018	700	680	97.1	615	**87.9**
2019	487	479	98.4	425	**87.3**
2020	516	499	96.7	481	**93.2**
2021	786	773	98.3	733	**93.3**
2022	1448	1378	95.2	1329	**91.8**
2023	1058	1003	94.8	1012	**95.7**
2024	1048	988	94.3	968	**92.4**
Subgroup Reach Travel < 3 calendar days					
Year		Total Converted for Reach Travel '<3 calendar days' subgroup	Percent of Total Conversions for Reach Travel '<3 calendar days' subgroup	Total GRA Exit for Reach Travel '<3 calendar days' subgroup	**Percent GRA Exit for Reach Travel '<3 calendar days' subgroup**
2016		1153	88.8	1048	**90.9**
2017		450	69.7	293	**65.1**
2018		518	74.0	468	**90.3**
2019		426	87.5	379	**89.0**
2020		393	76.2	374	**95.2**
2021		724	92.1	683	**94.3**
2022		907	62.6	846	**93.3**
2023		743	70.2	719	**96.8**
2024		797	76.0	771	**96.7**
Subgroup Reach Travel ≥ 3 calendar days					
Year		Total Converted for Reach Travel '≥3 calendar days' subgroup	Percent of Total Conversions for Reach Travel '≥3 calendar days' subgroup	Total GRA Exit for Reach Travel '≥3 calendar days' subgroup	**Percent GRA Exit for Reach Travel '≥3 calendar days' subgroup**
2016		109	8.4	94	**86.2**
2017		168	26.0	102	**60.7**
2018		162	23.1	141	**87**
2019		53	10.9	41	**77.4**
2020		106	20.5	97	**91.5**
2021		49	6.2	42	**85.7**
2022		471	32.5	444	**94.3**
2023		260	24.6	254	**97.7**
2024		191	18.2	185	**96.9**

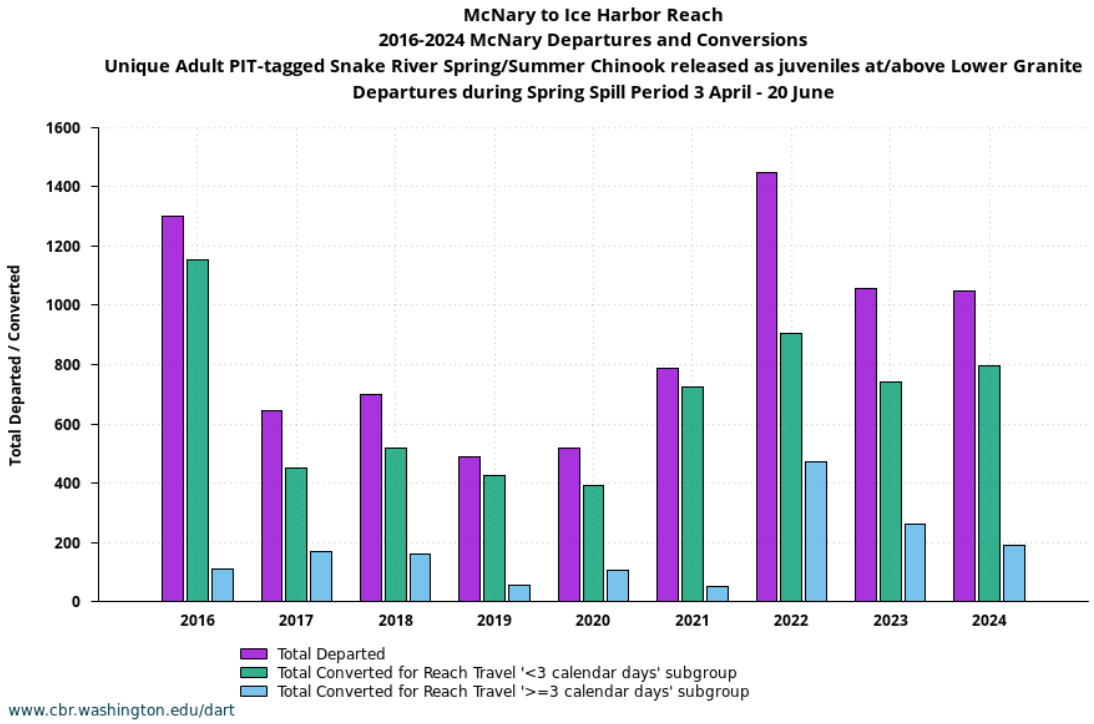


Figure 2. McNary to Ice Harbor 2016-2024 Total Departures and Conversions by Travel Time Subgroups.

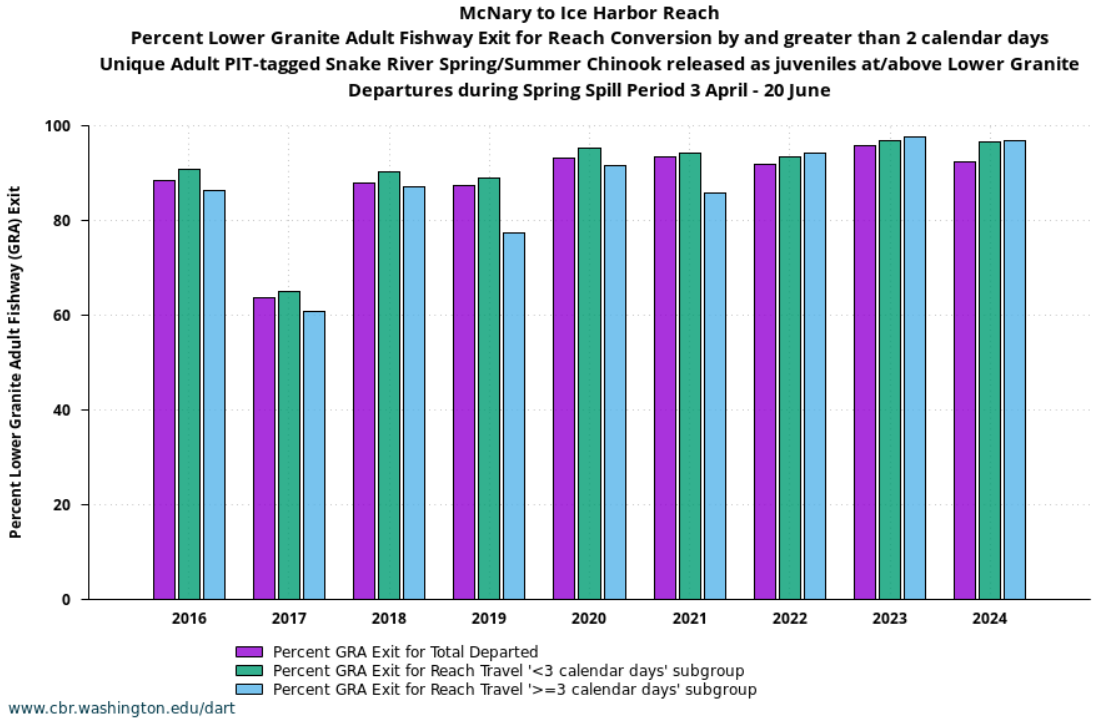


Figure 3. McNary to Ice Harbor 2016-2024 Percent GRA Exit for Total Departures and Travel Time Subgroups. See associated color-coded percentages in Table 1.

Table 2. Ice Harbor to Lower Monumental Reach Statistics for PIT-tagged Spring/Summer Adult Chinook departing McNary during Spring Spill Period, April 3-June 20, 2016-2024

Total Population					
Year	Total Departed	Total Converted	Percent Converted	Total GRA Exit	**Percent GRA Exit**
2016	1252	1234	98.6	1130	**90.3**
2017	611	596	97.5	392	**64.2**
2018	666	655	98.3	600	**90.1**
2019	474	468	98.7	415	**87.6**
2020	488	478	98.0	462	**94.7**
2021	754	753	99.9	708	**93.9**
2022	1221	1183	96.9	1138	**93.2**
2023	989	981	99.2	956	**96.7**
2024	973	957	98.4	940	**96.6**
Subgroup Reach Travel < 3 calendar days					
Year		Total Converted for Reach Travel '<3 calendar days' subgroup	Percent of Total Conversions for Reach Travel '<3 calendar days' subgroup	Total GRA Exit for Reach Travel '<3 calendar days' subgroup	**Percent GRA Exit for Reach Travel '<3 calendar days' subgroup**
2016		1162	92.8	1061	**91.3**
2017		502	82.2	335	**66.7**
2018		577	86.6	528	**91.5**
2019		433	91.4	383	**88.5**
2020		339	69.5	326	**96.2**
2021		706	93.6	666	**94.3**
2022		693	56.8	651	**93.9**
2023		822	83.1	798	**97.1**
2024		719	73.9	703	**97.8**
Subgroup Reach Travel ≥ 3 calendar days					
Year		Total Converted for Reach Travel '≥3 calendar days' subgroup	Percent of Total Conversions for Reach Travel '≥3 calendar days' subgroup	Total GRA Exit for Reach Travel '≥3 calendar days' subgroup	**Percent GRA Exit for Reach Travel '≥3 calendar days' subgroup**
2016		72	5.8	61	**84.7**
2017		94	15.4	50	**53.2**
2018		78	11.7	64	**82.1**
2019		35	7.4	31	**88.6**
2020		139	28.5	132	**95**
2021		47	6.2	42	**89.4**
2022		490	40.1	464	**94.7**
2023		159	16.1	157	**98.7**
2024		238	24.5	228	95.8

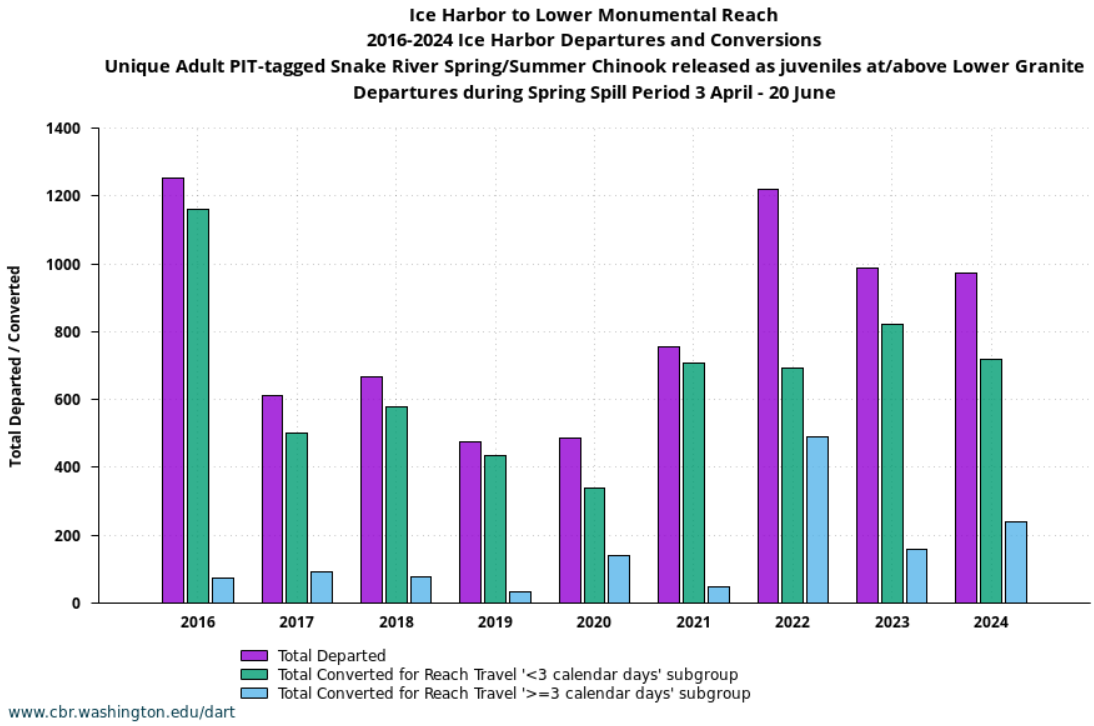


Figure 4. Ice Harbor to Lower Monumental 2016-2024 Total Departures and Conversions by Travel Time Subgroups.

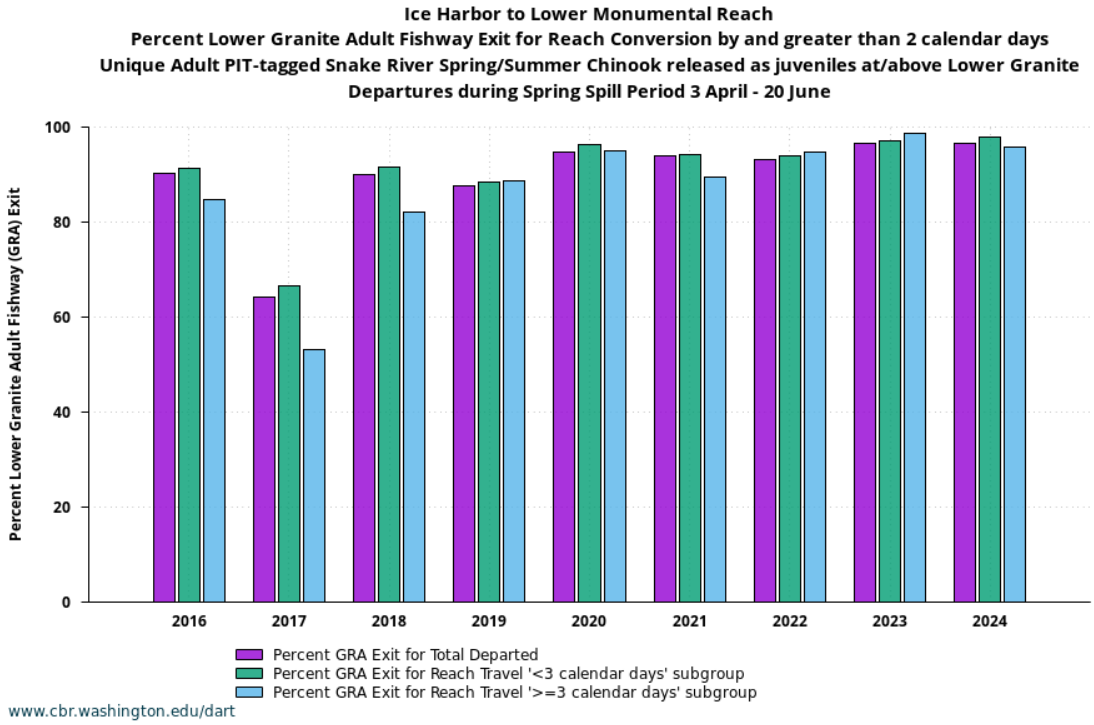


Figure 5. Ice Harbor to Lower Monumental 2016-2024 Percent GRA Exit for Total Departures and Travel Time Subgroups. See associated color-coded percentages in Table 2.

Table 3. Lower Monumental to Little Goose Reach Statistics for PIT-tagged Spring/Summer Adult Chinook departing McNary during Spring Spill Period, April 3-June 20, 2016-2024

Total Population					
Year	Total Departed	Total Converted	Percent Converted	Total GRA Exit	**Percent GRA Exit**
2016	1216	1192	98.0	1104	**90.8**
2017	598	592	99.0	391	**65.4**
2018	645	630	97.7	586	**90.9**
2019	468	455	97.2	410	**87.6**
2020	482	469	97.3	464	**96.3**
2021	749	732	97.7	706	**94.3**
2022	1156	1123	97.1	1088	**94.1**
2023	993	985	99.2	964	**97.1**
2024	943	921	97.7	916	**97.1**
Subgroup Reach Travel < 3 calendar days					
Year		Total Converted for Reach Travel '<3 calendar days' subgroup	Percent of Total Conversions for Reach Travel '<3 calendar days' subgroup	Total GRA Exit for Reach Travel '<3 calendar days' subgroup	**Percent GRA Exit for Reach Travel '<3 calendar days' subgroup**
2016		993	81.7	920	**92.6**
2017		329	55.0	221	**67.2**
2018		405	62.8	381	**94.1**
2019		212	45.3	185	**87.3**
2020		263	54.6	258	**98.1**
2021		531	70.9	516	**97.2**
2022		669	57.9	650	**97.2**
2023		783	78.9	766	**97.8**
2024		674	71.5	670	**99.4**
Subgroup Reach Travel ≥ 3 calendar days					
Year		Total Converted for Reach Travel '≥3 calendar days' subgroup	Percent of Total Conversions for Reach Travel '≥3 calendar days' subgroup	Total GRA Exit for Reach Travel '≥3 calendar days' subgroup	**Percent GRA Exit for Reach Travel '≥3 calendar days' subgroup**
2016		199	16.4	184	**92.5**
2017		263	44.0	169	**64.3**
2018		225	34.9	205	**91.1**
2019		243	51.9	225	**92.6**
2020		206	42.7	204	**99.0**
2021		201	26.8	189	**94.0**
2022		454	39.3	436	**96.0**
2023		202	20.3	197	**97.5**
2024		247	26.2	244	**98.8**

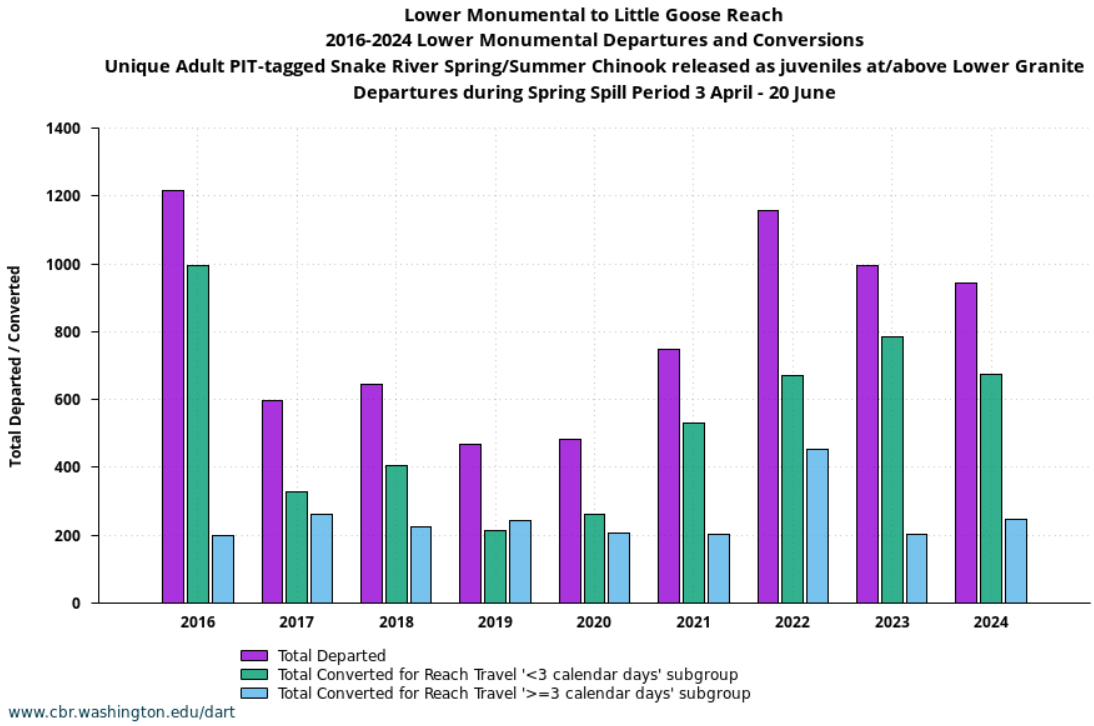


Figure 6. Lower Monumental to Little Goose 2016-2024 Total Departures and Conversions by Travel Time Subgroups.

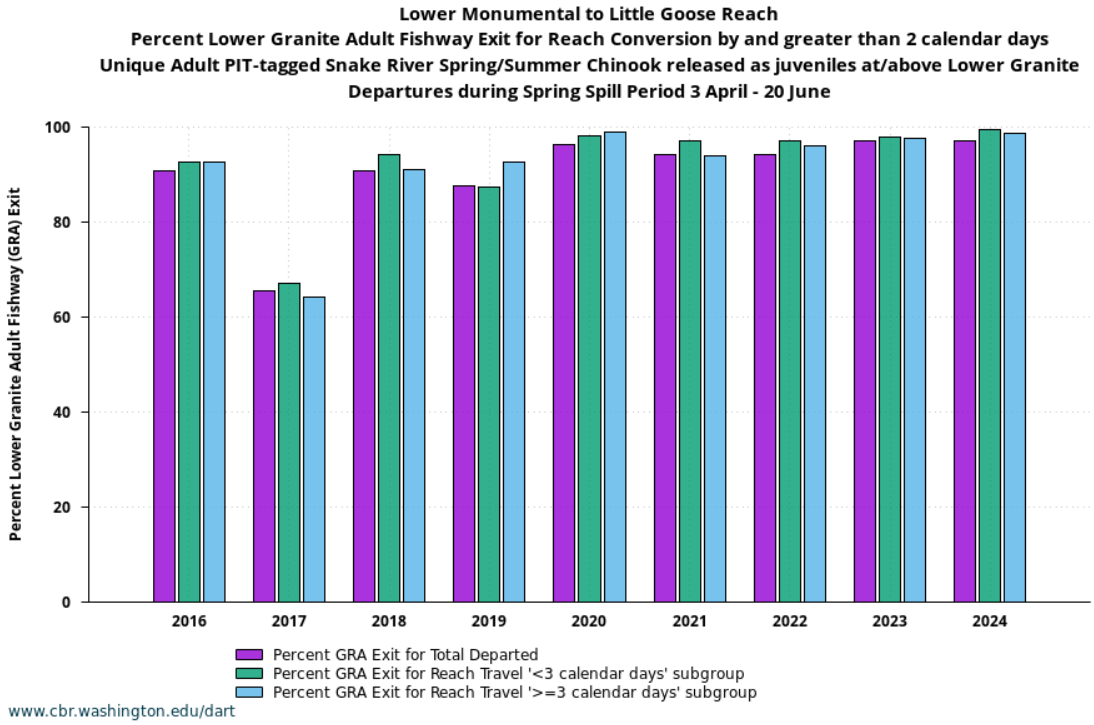


Figure 7. Lower Monumental to Little Goose 2016-2024 Percent GRA Exit for Total Departures and Travel Time Subgroups. See associated color-coded percentages in Table 3.

Table 4. Little Goose to Lower Granite Reach Statistics for PIT-tagged Spring/Summer Adult Chinook departing McNary during Spring Spill Period, April 3-June 20, 2016-2024

Total Population					
Year	Total Departed	Total Converted	Percent Converted	Total GRA Exit	**Percent GRA Exit**
2016	1165	1153	99.0	1073	**92.1**
2017	556	540	97.1	366	**65.8**
2018	583	580	99.5	540	**92.6**
2019	415	409	98.6	374	**90.1**
2020	455	450	98.9	447	**98.2**
2021	697	691	99.1	675	**96.8**
2022	1102	1078	97.8	1057	**95.9**
2023	946	939	99.3	922	**97.5**
2024	883	877	99.3	873	**98.9**
Subgroup Reach Travel < 3 calendar days					
Year		Total Converted for Reach Travel '<3 calendar days' subgroup	Percent of Total Conversions for Reach Travel '<3 calendar days' subgroup	Total GRA Exit for Reach Travel '<3 calendar days' subgroup	**Percent GRA Exit for Reach Travel '<3 calendar days' subgroup**
2016		998	85.7	928	**93.0**
2017		436	78.4	294	**67.4**
2018		526	90.2	490	**93.2**
2019		395	95.2	361	**91.4**
2020		407	89.5	404	**99.3**
2021		671	96.3	655	**97.6**
2022		953	86.5	934	**98.0**
2023		900	95.1	884	**98.2**
2024		838	94.9	835	**99.6**
Subgroup Reach Travel ≥ 3 calendar days					
Year		Total Converted for Reach Travel '≥3 calendar days' subgroup	Percent of Total Conversions for Reach Travel '≥3 calendar days' subgroup	Total GRA Exit for Reach Travel '≥3 calendar days' subgroup	**Percent GRA Exit for Reach Travel '≥3 calendar days' subgroup**
2016		155	13.3	145	**93.5**
2017		104	18.7	72	**69.2**
2018		54	9.3	50	**92.6**
2019		14	3.4	13	**92.9**
2020		43	9.5	43	**100.0**
2021		20	2.9	20	**100.0**
2022		125	11.3	123	**98.4**
2023		39	4.1	38	**97.4**
2024		39	4.4	38	**97.4**

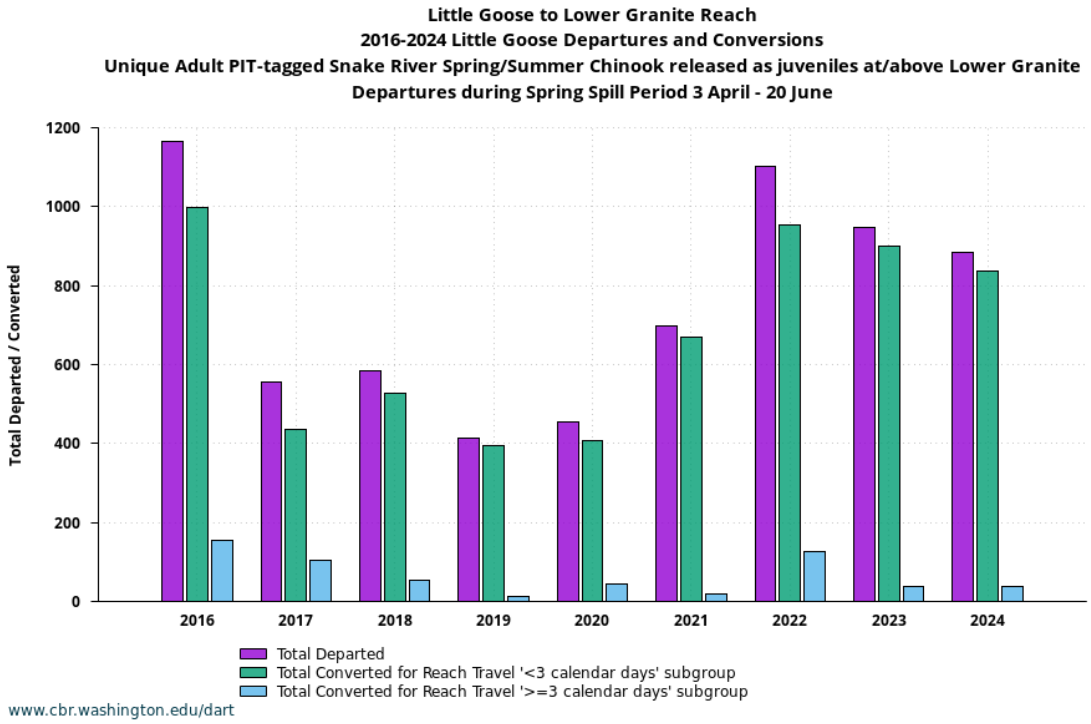


Figure 8. Little Goose to Lower Granite 2016-2024 Total Departures and Conversions by Travel Time Subgroups.

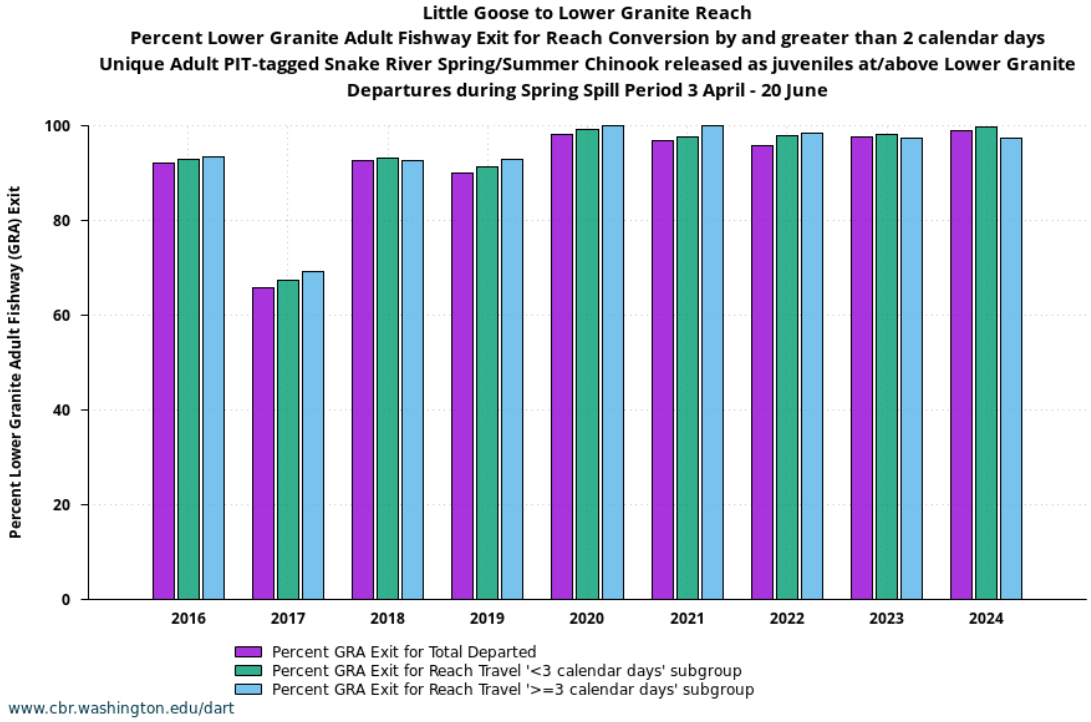


Figure 9. Little Goose to Lower Granite 2016-2024 Percent GRA Exit for Total Departures and Travel Time Subgroups. See associated color-coded percentages in Table 4.

1.2. Modeling the probability of exiting GRA with individual fish travel times

In addition to the visualizations in section 1.1, we modeled the probability of individual adult spring/summer Chinook salmon successfully migrating upstream of the hydrosystem (i.e., exiting GRA) in 2016-2024 in association with several covariates. We applied a mixed effects logistic regression with a logit link function to estimate the probability (p) of an individual adult fish (i) exiting GRA:

$$\text{logit}(p_i) = (b_0 + \varepsilon_y) + b_m x_{m,i} \qquad \text{(Eq. 1)}$$

$$\varepsilon_y \sim N(0, \sigma_y)$$

where b_0 is the fixed intercept, ε_y is the yearly random effect on the intercept, and b_m represents the fixed slopes for covariates $x_{m,i}$. The covariates with m = 1 through M = 5, respectively were as follows:

1) reach (MCN–ICH, ICH–LMN, LMN–GOA, GOA–GRA);
2) day-of-year an individual passed the lower dam of a reach;
3) number of times an individual ascended a reach, including incomplete reach ascents;
4) number of times an individual ascended a reach completely; and
5) a reach travel time indicator (0 for < 3 days; 1 for ≥ 3 days).

Another model was run, similar to Eq. 1, but with a reach travel time indicator that had a travel time cutpoint of 4 days instead of 3 days (i.e., 0 represents a reach travel time < 4 days, and 1 represents a reach travel time ≥ 4 days). Please note that the data used for these analyses were more detailed than the data used in section 1.1 because here multiple ascents per individual were examined while only the last ascent for each fish was used in section 1.1. The covariate data, that were not categorical variables, were scaled to a mean of 0 and 1 SD before running the analysis.

The analysis was run in **R** with the function **brm** from the package **brms**. For each model, 3 chains were run with 1500 iterations each, including a warmup of 500, thus yielding a total of 3000 samples from the Bayesian analysis. The model parameter estimates are in **Appendix 3. Additional results from GLMM of probability of exiting GRA**, and we summarize patterns below.

The estimated probabilities of exiting GRA ($\hat{p}$) were associated with longer reach travel times. Note that these estimates of $\hat{p}$ associated with reach travel times < 3 days and ≥ 3 days have overlapping credible intervals (Table 5a). The differences between these estimates of $\hat{p}$ were small, but not zero (Table 5b).

Table 5a. Estimated probabilities of exiting GRA ($\hat{p}$) by reach, with reach travel times < 3 or ≥ 3 days.

Reach	$\hat{p}$ associated with reach travel time < 3 days			$\hat{p}$ associated with reach travel time ≥ 3 days		
	Median	80% CI	95% CI	Median	80% CI	95% CI
GOA-GRA	0.956	0.928–0.972	0.900–0.980	0.945	0.912–0.966	0.878–0.974
LMA-GOA	0.948	0.916–0.967	0.883–0.976	0.936	0.898–0.959	0.858–0.969
ICH-LMA	0.926	0.881–0.953	0.840–0.965	0.909	0.857–0.942	0.807–0.956
MCA-ICH	0.921	0.874–0.949	0.829–0.963	0.903	0.848–0.938	0.795–0.954

Table 5b. Difference in estimated probabilities of exiting GRA with travel times, for each respective reach, that was ≥ 3 days and < 3 days.

Reach	Difference in $\hat{p}$ associated with reach travel time ≥ 3 days and < 3 days		
	Median	80% CI	95% CI
GOA-GRA	0.010	0.005–0.020	0.003–0.027
LMA-GOA	0.013	0.007–0.022	0.004–0.030
ICH-LMA	0.017	0.009–0.030	0.005–0.041
MCA-ICH	0.018	0.010–0.032	0.006–0.043

Reach-specific $\hat{p}$ were lowest for the MCN-ICH reach, followed by ICH-LMA, LMA-GOA, and GOA-GRA (Table 5a); thus, reach-specific $\hat{p}$ tended to decline the more distant the reach was to the ultimate location of passage examined, which in this analysis was GRA.

An analysis with detection sites upstream of GRA was not conducted as it would require more careful consideration of the network of PIT tag detection arrays and origins of each fish. DART has PIT tag data sets in years 2016-2024 already compiled and available for anyone interested in conducting such an analysis.

Similar and practically identical patterns were determined with the 4-day cutpoint in the reach travel time indicator (Table 6a. Estimated probabilities of exiting GRA ($\hat{p}$) by reach, with reach travel times < 4 or ≥ 4 days.

) compared to those with the 3-day cutpoint.

Table 6a. Estimated probabilities of exiting GRA ($\hat{p}$) by reach, with reach travel times < 4 or ≥ 4 days.

Reach	$\hat{p}$ associated with reach travel time < 4 days			$\hat{p}$ associated with reach travel time ≥ 4 days		
	Median	80% CI	95% CI	Median	80% CI	95% CI
GOA-GRA	0.957	0.930–0.972	0.904–0.979	0.946	0.912–0.965	0.881–0.974
LMA-GOA	0.949	0.917–0.967	0.890–0.975	0.935	0.896–0.959	0.861–0.969
ICH-LMA	0.928	0.884–0.953	0.848–0.964	0.910	0.856–0.942	0.811–0.956
MCA-ICH	0.922	0.876–0.949	0.836–0.961	0.903	0.846–0.937	0.800–0.953

Table 6a. Estimated probabilities of exiting GRA ($\widehat{p}$) by reach, with reach travel times < 4 or ≥ 4 days.

b. Difference in estimated probabilities of exiting GRA with travel times, for each respective reach, that was ≥ 4 days and < 4 days.

Reach	Difference in $\widehat{p}$ associated with reach travel time ≥ 4 days and < 4 days		
	Median	80% CI	95% CI
GOA-GRA	0.010	0.005–0.020	0.003–0.027
LMA-GOA	0.013	0.007–0.022	0.004–0.030
ICH-LMA	0.017	0.009–0.030	0.005–0.041
MCA-ICH	0.018	0.010–0.032	0.006–0.043

With regards to the effects from the other covariates examined, the negative effect from day-of-year suggests that p declined through the season, but that this effect was not as strong or disappeared later in the season for some reaches, given the positive interaction effects between reaches and day-of-year (see Appendix 3. Additional results from GLMM of probability of exiting GRA). The effect from number of ascents, including incomplete ascents, had no notable effect on $\hat{p}$. However, number of complete reach ascents had a negative effect on $\hat{p}$. An individual with multiple reach ascents means that the individual was swimming a lot to make multiple complete ascents through the reach.

In a few additional preliminary analyses, a simple model with only the reach travel time indicator as a covariate still yielded similar results to the respective effect in the full model (3-day cutpoint, single covariate model: $b_{m=5} =$ **-0.20** [95%CI -0.31 – -0.09];
3-day cutpoint, full model: $b_{m=5} =$ **-0.22** [95%CI -0.33 – -0.11];
4-day cutpoint, single covariate model: $b_{m=5} =$ **-0.20** [95%CI -0.35 – -0.07];
4-day cutpoint, full model: $b_{m=5} =$ **-0.24** [95%CI -0.38 – -0.09]).
It is also important to note that the analyses run did not include a random effect for individual fish to help handle repeated observations. Given the large sample sizes, the individual random effect was not included in the analyses.

Overall, higher probabilities of an individual fish exiting GRA were associated with shorter reach travel times (< 3 days vs ≥ 3 days; or <4 days vs ≥ 4 days). The results from a reach travel time indicator with a 4-day cutpoint was very similar to results with a 3-day cutpoint. We hope that this information is useful to the FPOM Task Group working on refining the adult fish delay criteria, and is an additional piece to consider among others, such as the meaningfulness of salmon in social and cultural contexts, effects from river conditions on the juvenile stage, mechanisms underlying adult migration behavior, and hydrosystem operations.

2. Adult delay trigger: temporal windows of the data and the trigger criteria

Is there a difference in the number of times adult delay trigger events would have occurred with different temporal resolutions in the data (i.e., 3-day vs 1-day cohorts) and in the trigger criteria (i.e., 3-day vs 4-day "dot" criteria)?

2.1. Data with 3-day vs 1-day cohorts

Looking at the historical data of PIT-tagged Chinook salmon from 2016–2024, the adult delay trigger would have occurred more often if using data from 3-day cohorts than 1-day cohorts. For example, with the 3-day adult delay trigger (i.e., 3 dots), in the MCN-ICH reach, the trigger would have occurred in five years (i.e., 2017, 2020, 2022-24) with 3-day cohort data, but only in 2020 and 2022 with 1-day cohort data (Table 7). Although in 2022, there would have been more occurrences with 1-day cohort data (17 occurrences) than with 3-day cohort data (14 occurrences). The higher number of occurrences with 1-day cohorts than with 3-day cohorts was not a frequent pattern, as the only occurrences of this was in the MCA-ICH reach in 2022 and the LMA-GOA reach in 2017.

Over the years and by reach, the largest number of occurrences was in the LMA-GOA reach (Table 9) and the smallest number of occurrences was in the GOA-GRA reach (Table 10). Overall, 3-day dots would have occurred about twice as often with 3-day cohorts than with 1-day cohorts in the MCN-ICH reach (Table 7), about 1.5 times as often in the ICH-LMA reach (Table 8), almost twice as often in the LMA-GOA reach (Table 9), and go from low numbers to almost zero (and to zero with 4-day dots) in the GOA-GRA reach (Table 10).

2.2. Adult delay trigger using 3-day vs 4-day "dot" criteria

In 2016-2024 and across all four reaches, there would have been more occurrences with the 3-day dots than the 4-day dots. In years when 3-day dots would have occurred, 4-day dots would have also occurred in almost all those years. Interestingly, in 2023 in the MCA-ICH reach, 3-day dots with 3-day cohorts occurred 10 times, but there were no occurrences of 4-day dots. Across years, 3-day dots occurred about 1.8 times more often than 4-day dots in the MCA-ICH reach (Table 7), about 1.4 times in the ICH-LMA reach (Table 8), about 1.4 times in the LMA-GOA reach (Table 9), and about 1.7 times in the GOA-GRA reach but generally there were few occurrences in this last reach (Table 10).

For additional details on the dates when the 3-day and 4-day dots occurred, based on data with 3-day or 1-day cohorts, see **Appendix 4. Dates when adult delay triggers would have occurred 2016-2024**.

McNary to Ice Harbor

Table 7. Number of times an adult delay trigger would have occurred in the MCA-ICH reach, based on adult delay triggers that were 3-day (i.e., 3 dots) or 4-day (i.e., 4 dots), and calculated with cumulative 3-day cohorts (with minimum of 7 fish per cohort) or 1-day cohorts (no minimum of fish per cohort).

Year	Number of occurrences of 3-day adult delay trigger (or 3 dots)		Number of occurrences of 4-day adult delay trigger (or 4 dots)	
	Cumulative 3-day cohort	1-day cohort	Cumulative 3-day cohort	1-day cohort
2016	0	0	0	0
2017	5	0	3	0
2018	0	0	0	0
2019	0	0	0	0
2020	4	1	2	0
2021	0	0	0	0
2022	14	17	13	15
2023	10	0	0	0
2024	5	0	3	0
Total in 2016–2024	38	18	21	15
Mean ± SD	4.2 ± 5.0	2.0 ± 5.6	2.3 ± 4.2	1.7 ± 5.0

Ice Harbor to Lower Monumental

Table 8. Number of times an adult delay trigger would have occurred in the ICH-LMA reach, based on adult delay triggers that were 3-day (i.e., 3 dots) or 4-day (i.e., 4 dots), and calculated with cumulative 3-day cohorts (with minimum of 7 fish per cohort) or 1-day cohorts (no minimum of fish per cohort).

Year	Number of occurrences of 3-day adult delay trigger (or 3 dots)		Number of occurrences of 4-day adult delay trigger (or 4 dots)	
	Cumulative 3-day cohort	1-day cohort	Cumulative 3-day cohort	1-day cohort
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	7	6	4	3
2021	0	0	0	0
2022	17	13	14	9
2023	1	1	0	0
2024	7	1	5	0
Total in 2016–2024	32	21	23	12
Mean ± SD	3.5 ± 5.9	2.3 ± 4.4	2.6 ± 4.7	1.3 ± 3.0

Lower Monumental to Little Goose

Table 9. Number of times an adult delay trigger would have occurred in the LMA-GOA reach, based on adult delay triggers that were 3-day (i.e., 3 dots) or 4-day (i.e., 4 dots), and calculated with cumulative 3-day cohorts (with minimum of 7 fish per cohort) or 1-day cohorts (no minimum of fish per cohort).

Year	Number of occurrences of 3-day adult delay trigger (or 3 dots)		Number of occurrences of 4-day adult delay trigger (or 4 dots)	
	Cumulative 3-day cohort	1-day cohort	Cumulative 3-day cohort	1-day cohort
2016	0	0	0	0
2017	10	12	6	9
2018	6	4	3	2
2019	22	10	19	6
2020	10	4	7	1
2021	1	0	0	0
2022	19	11	16	6
2023	5	0	4	0
2024	5	1	2	0
Total in 2016–2024	78	42	57	24
Mean ± SD	8.7 ± 7.5	4.7 ± 5.0	6.3 ± 6.8	2.7 ± 3.4

Little Goose to Lower Granite

Table 10. Number of times an adult delay trigger would have occurred in the GOA-GRA reach, based on adult delay triggers that were 3-day (i.e., 3 dots) or 4-day (i.e., 4 dots), and calculated with cumulative 3-day cohorts (with minimum of 7 fish per cohort) or 1-day cohorts (no minimum of fish per cohort).

Year	Number of occurrences of 3-day adult delay trigger (or 3 dots)		Number of occurrences of 4-day adult delay trigger (or 4 dots)	
	Cumulative 3-day cohort	1-day cohort	Cumulative 3-day cohort	1-day cohort
2016	0	0	0	0
2017	4	1	3	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
2022	1	0	0	0
2023	0	0	0	0
2024	0	0	0	0
Total in 2016–2024	5	1	3	0
Mean ± SD	0.6 ± 1.3	0.1 ± 0.3	0.3 ± 1.0	0.0 ± 0.0

3. Two-day Predicted Range of Cumulative Arrival Percent

What is an example demonstrating the method used to calculate the range of possible values of cumulative arrival percents 2 days from present date?

3.1. Output of 2-day Predicted Range with an example

This new feature is fully developed currently and is planned for release in early 2025, with any additional requests from the task group.

The example we provide is for the Ice Harbor to Lower Monumental (ICH-LMA) reach with data through 6/4/2024 (Figure 10 and Figure 11; Excel file available for download at https://www.cbr.washington.edu/dart/cs/data/reachdist.xlsx).

Running 3 Day Table Single Departure Event per TagID -- Adult PIT Tag
Data Through 06/04

Running 3 Days End Date (departure events >= 7) ▷ shaded red: Arrival on Avg (2) Day < 50%	Adult PIT Tag		Cumulative Arrival Percent Lower Monumental Calendar Days after Ice Harbor Departure ▷ shaded gray: 50% arrival day ▷ shaded gold: ConRate < 85% (at least 7 fish; fallback, delay, wander, harvest, mortality can all attribute to <100%) ▷ shaded green: Prediction Range based on departures and detections for individual days included in 3-day cohort							
	Departure Events Ice Harbor for period	Lower Monumental Entry Events for Fish departing ICH during period viable for Cumulative Arrival % calculations	0	1	2	3	4	5	6	Conversion Rate
2024-06-04	31	0	0.0	[16.1 - 58.1]	[32.3 - 96.8]					
2024-06-03	24	5	0.0	20.8	[54.2 - 83.3]	[58.3 - 91.7]				
2024-06-02	28	11	0.0	3.6	39.3	[60.7 - 64.3]	[82.1 - 92.9]			
2024-06-01	36	18	0.0	11.1	30.6	**50.0**	[66.7 - 72.2]	[75.0 - 86.1]		
2024-05-31	37	23	0.0	10.8	29.7	45.9	**62.2**	[73.0 - 78.4]	[73.0 - 91.9]	
2024-05-30	28	20	0.0	14.3	46.4	**53.6**	57.1	71.4	[71.4 - 89.3]	
2024-05-29	26	20	0.0	7.7	**50.0**	61.5	73.1	76.9	76.9	
2024-05-28	36	28	0.0	16.7	44.4	**61.1**	72.2	77.8	77.8	**77.8**
2024-05-27	42	35	0.0	21.4	47.6	**64.3**	71.4	81.0	81.0	**83.3**

Figure 10. Screenshot of data table in DART tool with new feature of 2-day Predicted Range.

The 2-day Predicted Range calculations use calculations from 1-day cohort departures and arrivals and Running 3-day cumulative cohort departures. (For explanations on 1-day departure cohorts, see Table 12; and for explanations on Running 3-day cohort, see Table 13.)

For Snake River single reaches, cumulative arrival is tracked separately for 0 to 6 calendar days after the departure day ('day-N') for each 1-day departure cohort. Over 6 days since departure, the cumulative arrival is enumerated in each individual departure date 'Conversion Rate'.

The 'Running 3-day' calculations are the sum of the three component 1-day departure cohorts. The 'Running 3-day' cohort on "date" D_j is comprised of 1-day departure cohorts (departures and arrivals) for the "date" D_j and the 2 prior dates D_{j-1} and D_{j-2}.

For example, Running 3-day cumulative date “2024-06-03” is comprised of 1-day departure cohorts for D_{j-2} = 2024-06-01, D_{j-1} = 2024-06-02, and D_j = 2024-06-03.

The ‘Running 3-day’ cumulative arrival for day-N is the sum of the cumulative arrivals for day-N for each of the three component days divided by the sum of departures for each of the three component days. Given the maximum data date, if arrivals for N days after departure is possible for each of the three component days, then day-N is considered ‘complete’ and arrival calculations are included in the DART tool results.

If N days since departure for at least one component 1-day departure cohort represent a date greater than the maximum data date, then accumulative arrivals for day-N is considered incomplete, ‘incomplete day-N’.

For one day and two days greater than the maximum complete day-N for the ‘Running 3-day’, arrivals are known for 2 or 1 of the component dates. If N is less than 6, prediction range calculations are made. Prediction range calculations are based on known departures and arrivals for the three component dates through the maximum data date.

In our ‘Running 3-day’ example for 2024-06-03, the maximum data date is 2024-06-04. Cumulative arrivals for day-0 and day-1, arrivals for 0 and 1 day since departure, respectively, are complete. Arrivals are known for at least one component date for day-2 and day-3 (Table 11).

Table 11. Arrivals Known for N days since Departure with 6/4 Maximum Data Date

Running 3-day for "6/3"	day-0 ‘complete’	day-1 ‘complete’	incomplete day-2 Prediction Day 1	incomplete day-3 Prediction Day 2
Arrivals known for day-N with Max Date 6/4	1-day cohort for 6/1, 6/2, 6/3	1-day cohort for 6/1, 6/2, 6/3	1-day cohort for 6/1, 6/2	1-day cohort for 6/1

The **predicted range lower limit** for ‘incomplete day-N’ is:

Cumulative arrivals for ‘incomplete day-N’ / 3 day sum of departures

where “Cumulative arrivals for ‘incomplete day-N’” is:

- On prediction day 1 (one day greater than last complete day-N):
  - Available cumulative arrival for running 3-day through day-(*N-1*) plus the known arrivals for N days since departure for 1-day departures cohorts, i.e., D_{j-1} and D_{j-2}.

- On prediction day 2 (two days greater than last complete day-N):
  - Available cumulative arrival for running 3-day through day-(*N-1*) plus the known arrivals for N days since departure for 1-day departures cohorts, i.e., D_{j-2}.

The **predicted range upper limit** for ‘incomplete day-N’ is:

Total possible arrivals for ‘incomplete day-N’ / 3 day sum of departures

The “Total possible arrivals for ‘incomplete day-N’” is the sum of known arrivals for day-N and “Possible new arrivals” for each 1-day departure cohort for day-N, i.e., not arrived as of N days since departure. Each 1-day departure cohort can only be counted in 'arrivals' or 'possible new' not both for incomplete day-N.

“Possible new arrivals” is:

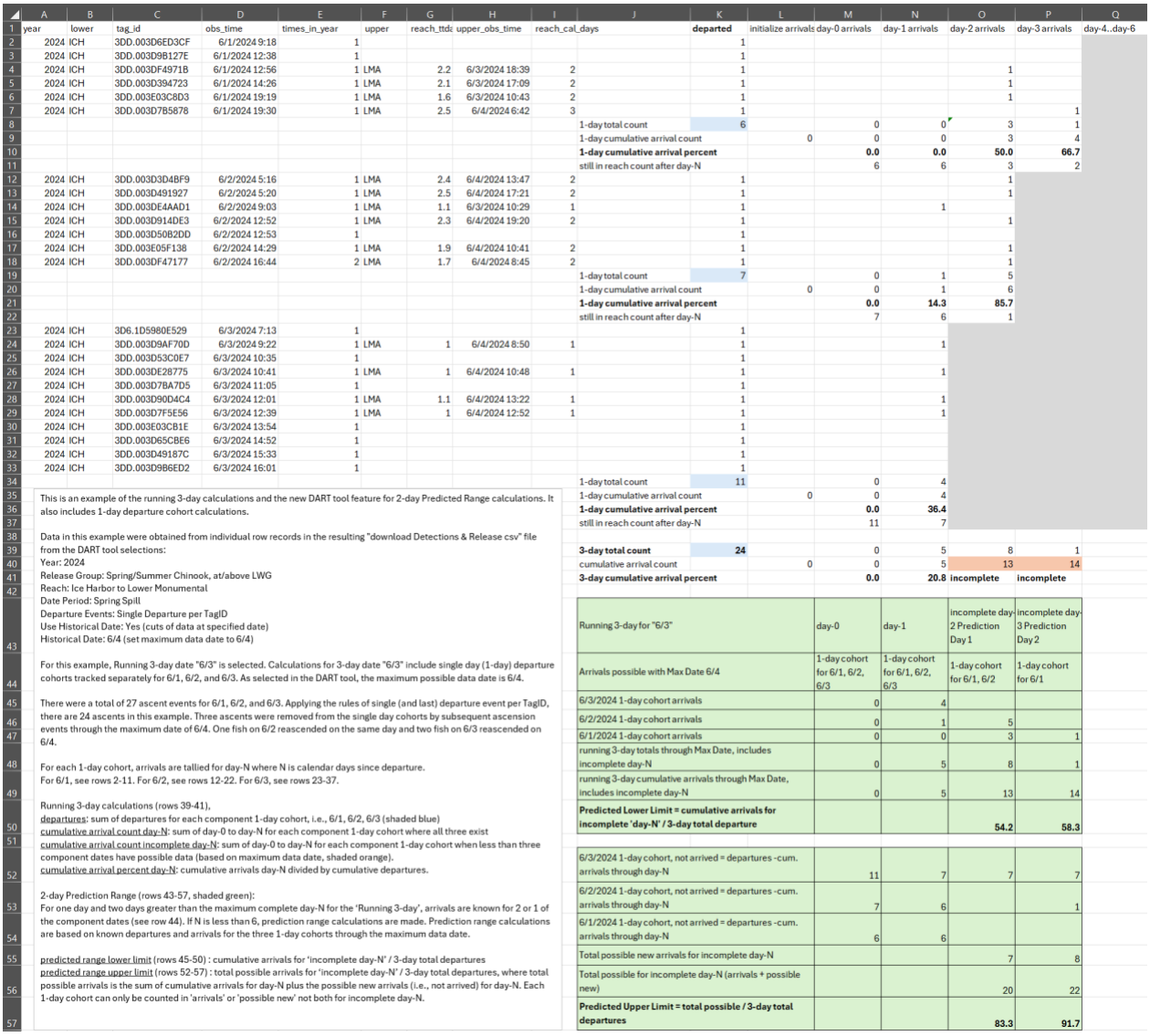
Sum of each component date:

Departures for 1-day departure cohort– cumulative arrival count for 1-day departure cohort for day-N

- On prediction day 1 (one day greater than last complete day-N):
    - Arrivals are known for D_{j-1} and D_{j-2} and are accounted for in the sum of known arrivals for day-N. For D_j, day-N represents a date greater than the maximum data date. “Possible new arrivals” are calculated for D_j: departures for D_j minus the cumulative arrival count through day-N for D_j. “Possible new arrivals” is equivalent to fish not arrived for D_j.

- On prediction day 2 (two days greater than last complete day-N):
    - Arrivals are known for D_{j-2} and are accounted for in the sum of known arrivals for day-N. For D_j and D_{j-1}, day-N represents a date greater than the maximum data date. “Possible new arrivals” are calculated for both D_j and D_{j-1} and then summed.

For more information, see **Appendix 5. DART Tool 2-day Predicted Range**.



year	lower	tag_id	obs_time	times_in_year	upper	reach_ttda	upper_obs_time	reach_cal	days	departed	initialize arrivals	day-0 arrivals	day-1 arrivals	day-2 arrivals	day-3 arrivals	day-4..day-6
2024	ICH	3DD.003D6ED3CF	6/1/2024 9:18	1						1						
2024	ICH	3DD.003D9B127E	6/1/2024 12:38	1						1						
2024	ICH	3DD.003DF4971B	6/1/2024 12:56	1	LMA	2.2	6/3/2024 18:39	2		1				1		
2024	ICH	3DD.003D394723	6/1/2024 14:26	1	LMA	2.1	6/3/2024 17:09	2		1				1		
2024	ICH	3DD.003E03C8D3	6/1/2024 19:19	1	LMA	1.6	6/3/2024 10:43	2		1				1		
2024	ICH	3DD.003D7B5878	6/1/2024 19:30	1	LMA	2.5	6/4/2024 6:42	3		1					1	
									1-day total count	6		0	0	3	1	
									1-day cumulative arrival count		0	0	0	3	4	
									1-day cumulative arrival percent			**0.0**	**0.0**	**50.0**	**66.7**	
									still in reach count after day-N			6	6	3	2	
2024	ICH	3DD.003D3D4BF9	6/2/2024 5:16	1	LMA	2.4	6/4/2024 13:47	2		1				1		
2024	ICH	3DD.003D491927	6/2/2024 5:20	1	LMA	2.5	6/4/2024 17:21	2		1				1		
2024	ICH	3DD.003DE4AAD1	6/2/2024 9:03	1	LMA	1.1	6/3/2024 10:29	1		1			1			
2024	ICH	3DD.003D914DE3	6/2/2024 12:52	1	LMA	2.3	6/4/2024 19:20	2		1				1		
2024	ICH	3DD.003D50B2DD	6/2/2024 12:53	1						1						
2024	ICH	3DD.003E05F138	6/2/2024 14:29	1	LMA	1.9	6/4/2024 10:41	2		1				1		
2024	ICH	3DD.003DF47177	6/2/2024 16:44	2	LMA	1.7	6/4/2024 8:45	2		1				1		
									1-day total count	7		0	1	5		
									1-day cumulative arrival count		0	0	1	6		
									1-day cumulative arrival percent			**0.0**	**14.3**	**85.7**		
									still in reach count after day-N			7	6	1		
2024	ICH	3D6.1D5980E529	6/3/2024 7:13	1						1						
2024	ICH	3DD.003D9AF70D	6/3/2024 9:22	1	LMA	1	6/4/2024 8:50	1		1				1		
2024	ICH	3DD.003D53C0E7	6/3/2024 10:35	1						1						
2024	ICH	3DD.003DE28775	6/3/2024 10:41	1	LMA	1	6/4/2024 10:48	1		1				1		
2024	ICH	3DD.003D7BA7D5	6/3/2024 11:05	1						1						
2024	ICH	3DD.003D90D4C4	6/3/2024 12:01	1	LMA	1.1	6/4/2024 13:22	1		1				1		
2024	ICH	3DD.003D7F5E56	6/3/2024 12:39	1	LMA	1	6/4/2024 12:52	1		1				1		
2024	ICH	3DD.003E03CB1E	6/3/2024 13:54	1						1						
2024	ICH	3DD.003D65CBE6	6/3/2024 14:52	1						1						
2024	ICH	3DD.003D49187C	6/3/2024 15:33	1						1						
2024	ICH	3DD.003D9B6ED2	6/3/2024 16:01	1						1						
									1-day total count	11		0	4			
									1-day cumulative arrival count		0	0	4			
									1-day cumulative arrival percent			**0.0**	**36.4**			
									still in reach count after day-N			11	7			
									3-day total count	**24**		0	5	8	1	
									cumulative arrival count		0	0	5	13	14	
									3-day cumulative arrival percent			**0.0**	**20.8**	**incomplete**	**incomplete**	

This is an example of the running 3-day calculations and the new DART tool feature for 2-day Predicted Range calculations. It also includes 1-day departure cohort calculations.

Data in this example were obtained from individual row records in the resulting "download Detections & Release csv" file from the DART tool selections:
Year: 2024
Release Group: Spring/Summer Chinook, at/above LWG
Reach: Ice Harbor to Lower Monumental
Date Period: Spring Spill
Departure Events: Single Departure per TagID
Use Historical Date: Yes (cuts of data at specified date)
Historical Date: 6/4 (set maximum data date to 6/4)

For this example, Running 3-day date "6/3" is selected. Calculations for 3-day date "6/3" include single day (1-day) departure cohorts tracked separately for 6/1, 6/2, and 6/3. As selected in the DART tool, the maximum possible data date is 6/4.

There were a total of 27 ascent events for 6/1, 6/2, and 6/3. Applying the rules of single (and last) departure event per TagID, there are 24 ascents in this example. Three ascents were removed from the single day cohorts by subsequent ascension events through the maximum date of 6/4. One fish on 6/2 reascended on the same day and two fish on 6/3 reascended on 6/4.

For each 1-day cohort, arrivals are tallied for day-N where N is calendar days since departure.
For 6/1, see rows 2-11. For 6/2, see rows 12-22. For 6/3, see rows 23-37.

Running 3-day calculations (rows 39-41),
departures: sum of departures for each component 1-day cohort, i.e., 6/1, 6/2, 6/3 (shaded blue)
cumulative arrival count day-N: sum of day-0 to day-N for each component 1-day cohort where all three exist
cumulative arrival count incomplete day-N: sum of day-0 to day-N for each component 1-day cohort when less than three component dates have possible data (based on maximum data date, shaded orange).
cumulative arrival percent day-N: cumulative arrivals day-N divided by cumulative departures.

2-day Prediction Range (rows 43-57, shaded green):
For one day and two days greater than the maximum complete day-N for the 'Running 3-day', arrivals are known for 2 or 1 of the component dates (see row 44). If N is less than 6, prediction range calculations are made. Prediction range calculations are based on known departures and arrivals for the three 1-day cohorts through the maximum data date.

predicted range lower limit (rows 45-50) : cumulative arrivals for 'incomplete day-N' / 3-day total departures
predicted range upper limit (rows 52-57) : total possible arrivals for 'incomplete day-N' / 3-day total departures, where total possible arrivals is the sum of cumulative arrivals for day-N plus the possible new arrivals (i.e., not arrived) for day-N. Each 1-day cohort can only be counted in 'arrivals' or 'possible new' not both for incomplete day-N.

Running 3-day for "6/3"	day-0	day-1	incomplete day-2 Prediction Day 1	incomplete day-3 Prediction Day 2
Arrivals possible with Max Date 6/4	1-day cohort for 6/1, 6/2, 6/3	1-day cohort for 6/1, 6/2, 6/3	1-day cohort for 6/1, 6/2	1-day cohort for 6/1
6/3/2024 1-day cohort arrivals	0	4		
6/2/2024 1-day cohort arrivals	0	1	5	
6/1/2024 1-day cohort arrivals	0	0	3	1
running 3-day totals through Max Date, includes incomplete day-N	0	5	8	1
running 3-day cumulative arrivals through Max Date, includes incomplete day-N	0	5	13	14
Predicted Lower Limit = cumulative arrivals for incomplete 'day-N' / 3-day total departure			**54.2**	**58.3**
6/3/2024 1-day cohort, not arrived = departures -cum. arrivals through day-N	11	7	7	7
6/2/2024 1-day cohort, not arrived = departures -cum. arrivals through day-N	7	6		1
6/1/2024 1-day cohort, not arrived = departures -cum. arrivals through day-N	6	6		
Total possible new arrivals for incomplete day-N			7	8
Total possible for incomplete day-N (arrivals + possible new)			20	22
Predicted Upper Limit = total possible / 3-day total departures			**83.3**	**91.7**

Figure 11. Screenshot of the Excel file demonstrating an example of calculations from the DART tool, Adult Reach Distribution and Delay. Download the Excel file at: https://www.cbr.washington.edu/dart/cs/data/reachdist.xlsx.

Table 12. Single day (i.e., 1-day) departure cohorts with an example of specific dates from 6/1 to 6/10.

Actual Data Date of Arrival	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8	6/9	6/10
N days since Departure			Day-0 arrivals	Day-1 arrivals	Day-2 arrivals	Day-3 arrivals	Day-4 arrivals	Day-5 arrivals	Day-6 arrivals	YTD
"D_j" 1-day cohort 6/3 departures (actual data date)			arrivals ←	cumulative ←	cumulative ←	cumulative ←	cumulative ←	cumulative ←	cumulative ←	cumulative
N days since Departure		Day-0 arrivals	Day-1 arrivals	Day-2 arrivals	Day-3 arrivals	Day-4 arrivals	Day-5 arrivals	Day-6 arrivals	YTD	
"D_{j-1}" 1-day cohort 6/2 departures (actual data date)		arrivals ←	cumulative							
N days since Departure	Day-0 arrivals	Day-1 arrivals	Day-2 arrivals	Day-3 arrivals	Day-4 arrivals	Day-5 arrivals	Day-6 arrivals	YTD		
"D_{j-2}" 1-day cohort 6/1 departures (actual data date)	arrivals ←	cumulative								

Table 13. Running 3-day cohort. Running 3-day cohort for "D_j" is comprised of three 1-day departure cohorts for D_j, D_{j-1}, and D_{j-2}.

N days since Departure	Day-0 arrivals	Day-1 arrivals	Day-2 arrivals	Day-3 arrivals	Day-4 arrivals	Day-5 arrivals	Day-6 arrivals	YTD
Running 3-day "6/3"	Sum of Day-0 arrivals for D_j, D_{j-1}, and D_{j-2}. See Table 12 for staggered data date associated with arrival days.	Sum of Day-1 arrivals for D_j, D_{j-1}, and D_{j-2}.	Sum of Day-2 arrivals for D_j, D_{j-1}, and D_{j-2}.	Sum of Day-3 arrivals	Sum of Day-4 arrivals	Sum of Day-5 arrivals	Sum of Day-6 arrivals	
Cumulative arrivals for Running 3-day "6/3"	arrivals ←	cumulative ←	cumulative ←	cumulative ←	cumulative ←	cumulative ←	cumulative	

Appendix

Appendix 1. Data set details and additional information related to DART tool

The data set is based on PTAGIS interrogation and tagging data sets as implemented in the DART database (updated daily).

On a daily basis, the DART database loads current PTAGIS, Smolt Index, River Conditions, and Adult Visual Counts datasets from primary sources.
Three populations based on release attributes are tracked separately for analysis.

1. Spring/Summer Chinook, juveniles released at/above Lower Granite, includes Unknown-run tagged at Lower Granite in April and May in same year as release. Tracked for spring spill period at Snake River dams, April 3 - June 20 and adult visual counts spring/summer run dates, April - August.
2. Spring/Summer Chinook, juveniles released at/above McNary. Tracked for spring spill period at mainstem Columbia River dams, April 10 - June 15.
3. Fall Chinook, juveniles released at/above Lower Granite, includes Unknown-run tagged at Lower Granite after June in same year as release and Unknown-run tagged by coord_id "WPC". Tracked adult visual count fall run dates, August - November.

For each unique Tag Id detected at the lower project as life stage adult, individual coil detections are examined to establish movement maps through the ladders and determine departure dates (can be more than one). Tag Ids are grouped by departure date into a daily cohort and each departure-date cohort is tracked separately for reach travel time, conversion rate, and arrival. Fallback, delay, wander, harvest, and/or mortality may result in <100% daily cohort conversion rate; fallback, wander, harvest and mortality are not included in these analyses. The PIT Tag population as a whole is tracked by unique Tag Id for YTD calculations of harmonic mean reach travel time (TT) and conversion rate.

On a date-specific basis, a unique population departing the lower project is established. Ascent events are not restricted to calendar date. This date-specific unique population is tracked to determine cumulative arrival percent at the upper project, harmonic mean TT, and conversion rate. A history of more than 1 ascent event for a TagID is tracked. This may impact arrival success and travel time.

In this memo, we focus on 4 reaches for Spring/Summer Chinook destined to return above Lower Granite:

- McNary-Ice Harbor,
- Ice Harbor-Lower Monumental,
- Lower Monumental-Little Goose,
- Little Goose-Lower Granite.

For each focal reach, we examine upstream reach travel time and conversion and exit from Lower Granite for 2016-2024. The start year of 2016 was selected since it is the first year where the entrance and exit coils were operational in the Lower Granite adult fishway ladder. With these coils, it is possible to examine individual coil detections for a fish and assign an outcome of “exit from Lower Granite”.

As a new feature of the DART Tool, additional detection information is added to the “download Detection & Release csv” file. For the DART Tool, these fields are added for informational purposes only and are not part of the DART Tool analysis.

- GRA_exit_flag: 0|1 flag for GRA exit
- GRA_exit: date and time GRA exit
- GRA_exit_coil: last coil for GRA exit
- above_GRA_flag: 0|1 flag for "detection" above GRA
- last_above_datetime: date and time last "detection" above GRA
- last_above_site: site last "detection" above GRA
- last_above_rkm: rkm last "detection" above GRA
- last_above_detect_type: detection type last "detection" above GRA: INT (interrogation), REC (recapture), MRT (mortality)

This feature is in development and is not released publicly at this time.

The files are packaged and made available on our website:
https://www.cbr.washington.edu/dart/cs/data/reachdist.zip

reachdist_zip

detection_details: subfolder contains the detection and release detail files with all ascent events for the population in the reach from the DART Tool with new fields for each focal reach and year. Each row in the file represents an ascent/reascent event for fish detected at the lower project of the reach. All fields:

- year: year of detection, lower
- lower: lower project 3-letter code
- obs_doy: day of year, lower project departure
- obs_date: date, lower project departure
- rel_rear_type: PTAGIS rear type at release
- tag_id: PTAGIS tag id
- last_coil: last coil, lower proj departure
- ladder_side: ladder side, lower proj departure
- obs_time: date and time, lower proj departure
- since_rel_ttdays: travel time in days (1 decimal place of precision) between release date and time and lower proj date and time
- ladder_tthours: hours in lower project ladder from first detection to last detection of ascent
- upper: upper project 3-letter code

- reach_ttdays: reach travel time in days (1 decimal place of precision), first arrival detection upper - departure lower
- upper_obs_time: date and time, first detection upper project
- upper_diff_seconds: reach travel time in seconds (used for sorting)
- upper_doy: day of year, upper project arrival
- reach_cal_days: reach travel in number of calendar days (whole number)
- times_in_year: number of ascents in year (within spill period analysis)
- rel_year: release year
- rel_time: release date and time
- rel_run: release run
- rel_length: release length
- rel_site: release site
- file_id: PTAGIS tagging file id
- rel_rkm: release rkm
- rel_HUC: release HUC
- ESU: DART ESU identification
- rel_coord: release tag coordinator code
- GRA_exit_flag: 0|1 flag for GRA exit [not used in DART Tool calculations/results]
- GRA_exit: date and time GRA exit [not used in DART Tool calculations/results]
- GRA_exit_coil: last coil for GRA exit [not used in DART Tool calculations/results]
- above_GRA_flag: 0|1 flag for "detection" above GRA [not used in DART Tool calculations/results]
- last_above_datetime: date and time last "detection" above GRA [not used in DART Tool calculations/results]
- last_above_site: site last "detection" above GRA [not used in DART Tool calculations/results]
- last_above_rkm: rkm last "detection" above GRA [not used in DART Tool calculations/results]
- last_above_detect_type: detection type last "detection" above GRA: INT (interrogation), REC (recapture), MRT (mortality) [not used in DART Tool calculations/results]

dotdates: subfolder contains post-processing of DART Tool results for each focal reach and year of dates when the criteria for “Potential Delay Alert: Cumulative Arrival Percent is less than 50% by ‘Average’ Arrival Day 2 (<3 Days)” occurred applies to both running 3-day cumulative cohorts (3 Day Table in DART Tool) and 1-day cohorts (Daily Table in DART Tool).

The average travel days and arrival percent criterion are based on historical observations for each reach and population. For the full history, see the Summary table included on the main DART Tool webpage, below the query form, https://cbr.washington.edu/dart/query/pitadult_reachdist.

Appendix 2. Daily % conversions exiting GRA

comparing reach travel times <3 calendar days vs ≥3 calendar days

For each focal reach, we examine the upstream reach travel days and conversion and exit from Lower Granite for 2016-2024 for 1-day departure cohorts. The start year of 2016 was selected since it is the first year where the entrance and exit coils were operational in the Lower Granite adult fishway ladder. With these coils, it is possible to examine individual coil detections for a fish and assign an outcome of "exit from Lower Granite".

Input files used for all calculations and figures provided in subfolder "detection_details": https://www.cbr.washington.edu/dart/cs/data/reachdist.zip

We apply the rules of **Single Departure Event per TagID** for Departure Event Calculations from the DART Tool. On reascent and departure, the TagID is removed from previous departure date cohort and daily calculations are adjusted. That is, each TagID has only one departure event per season, its last within the spill season dates.

McNary to Ice Harbor

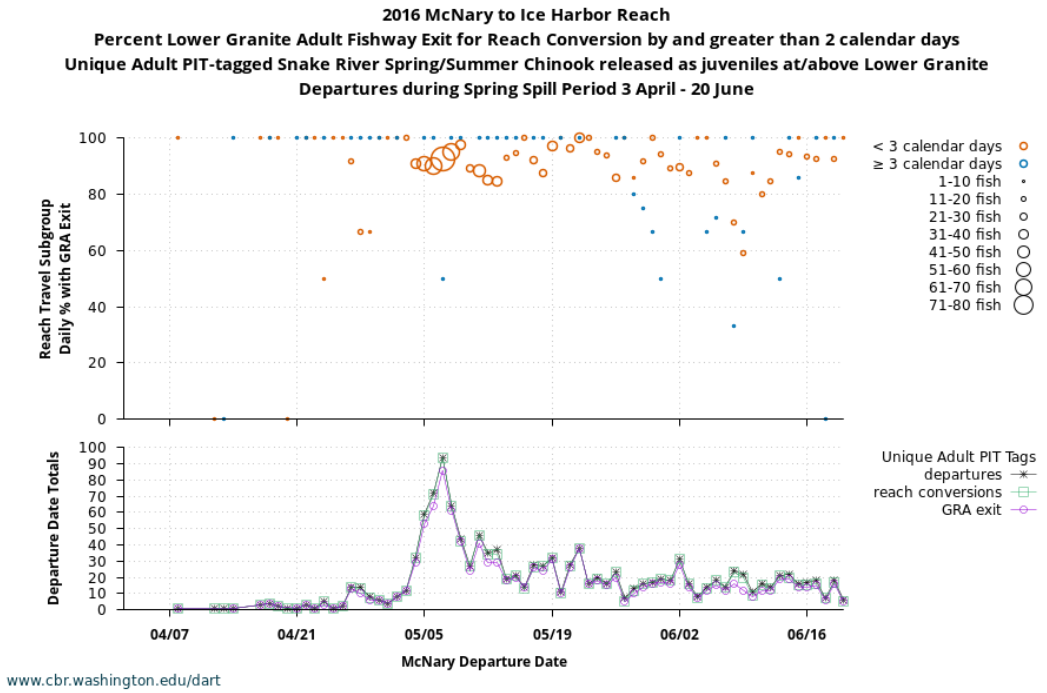


Figure 12. McNary to Ice Harbor 2016 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

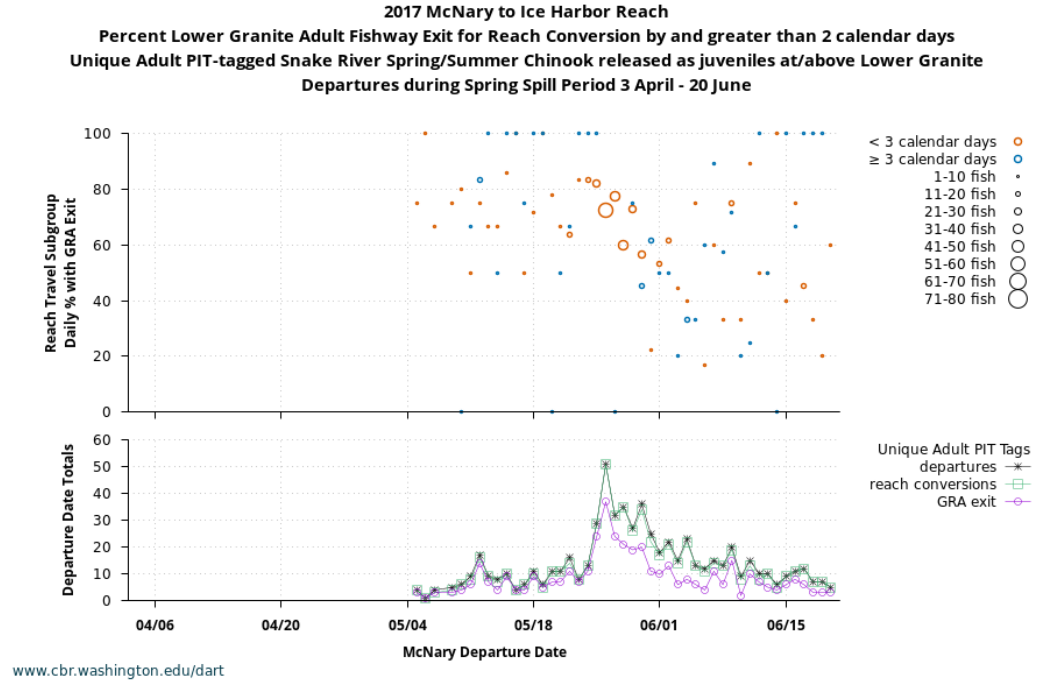


Figure 13. McNary to Ice Harbor 2017 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

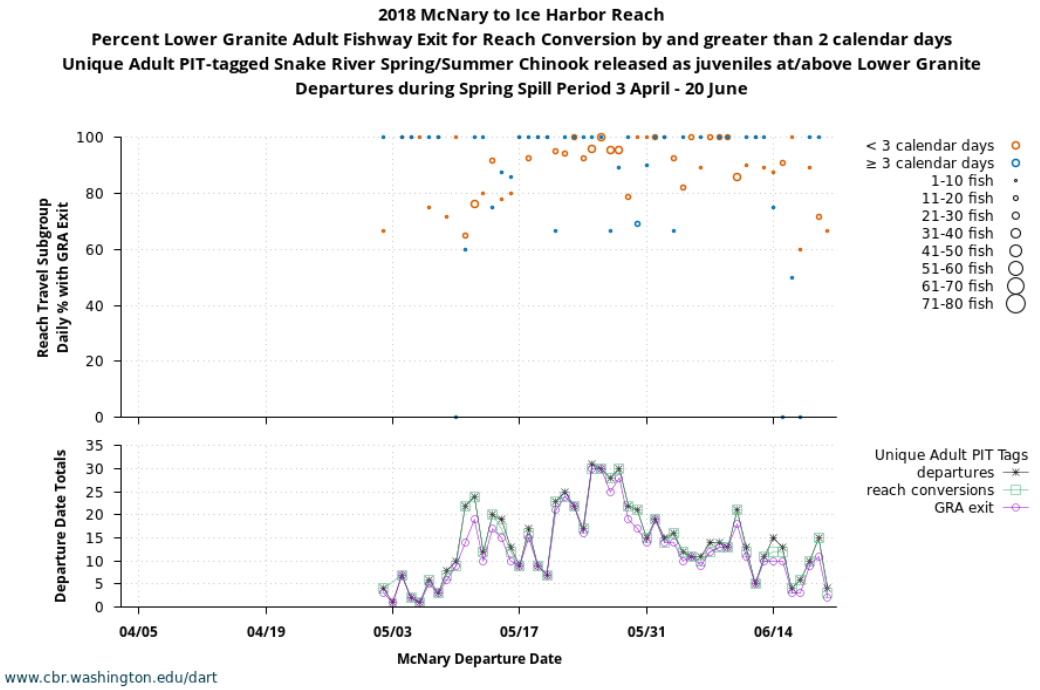


Figure 14. McNary to Ice Harbor 2018 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

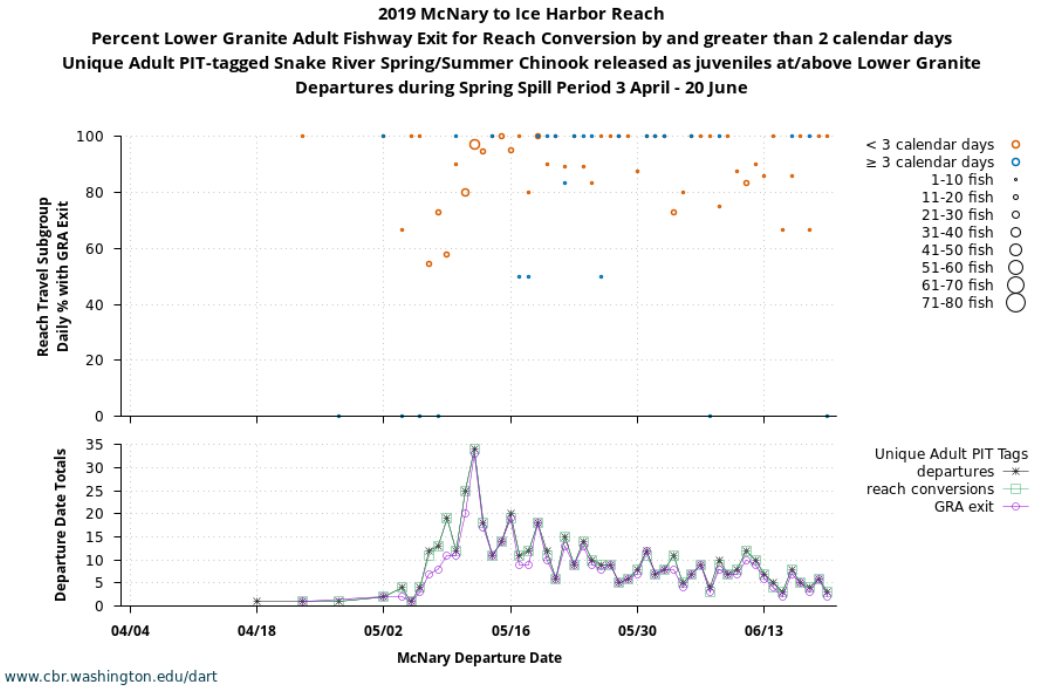


Figure 15. McNary to Ice Harbor 2019 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

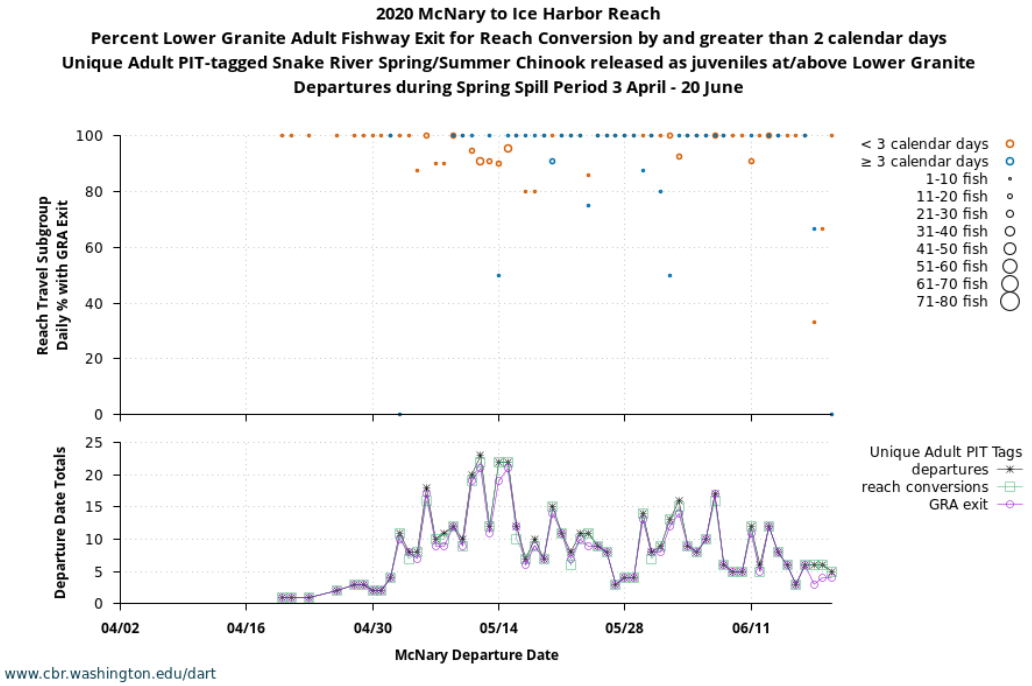


Figure 16. McNary to Ice Harbor 2020 Travel Time Subgroups Daily Percent GRA Exit for Single Departure Date Cohorts.

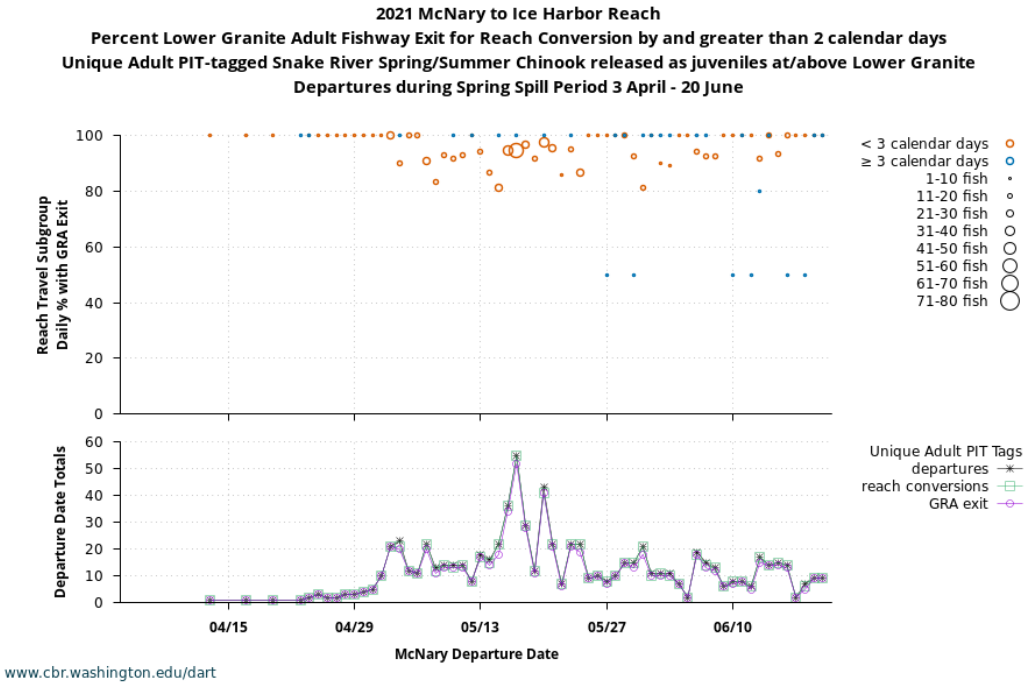


Figure 17. McNary to Ice Harbor 2021 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

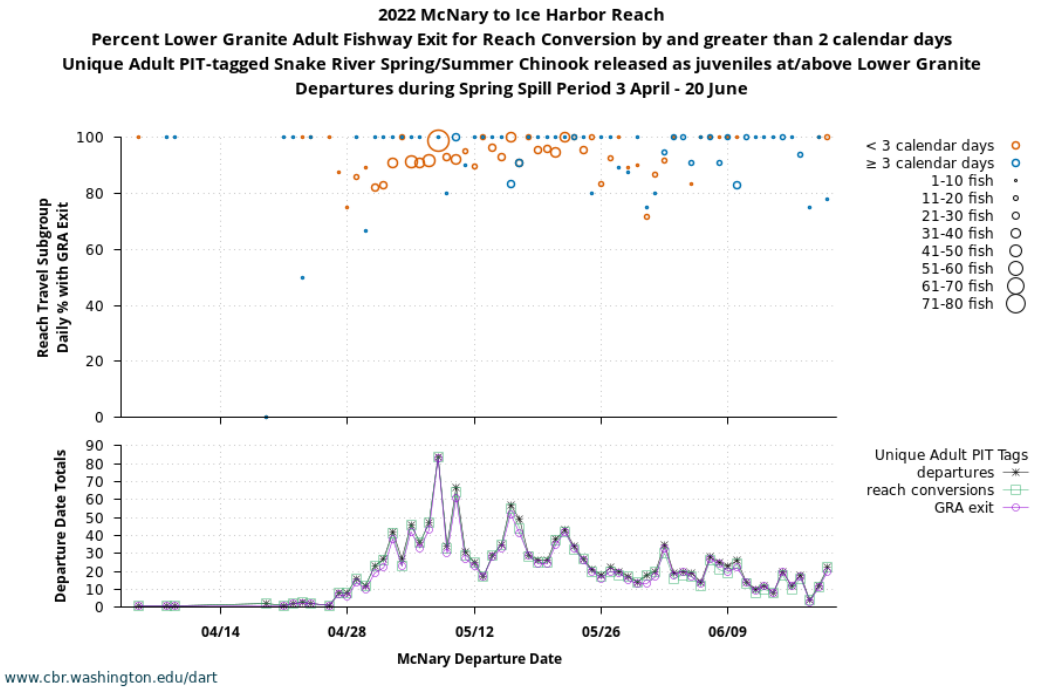


Figure 18. McNary to Ice Harbor 2022 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

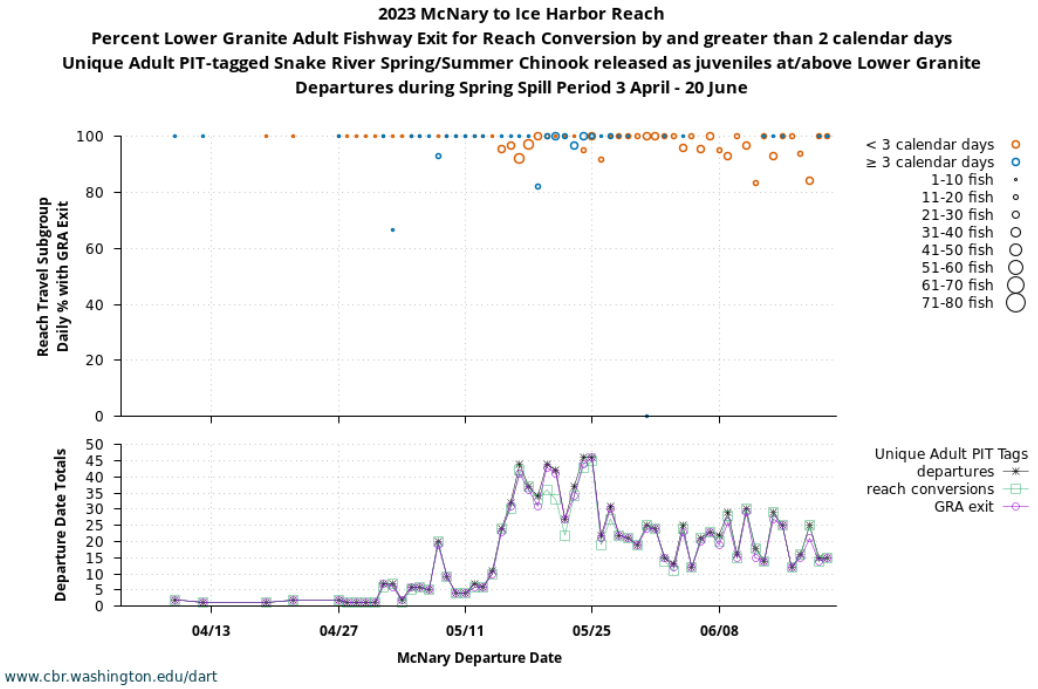


Figure 19. McNary to Ice Harbor 2023 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

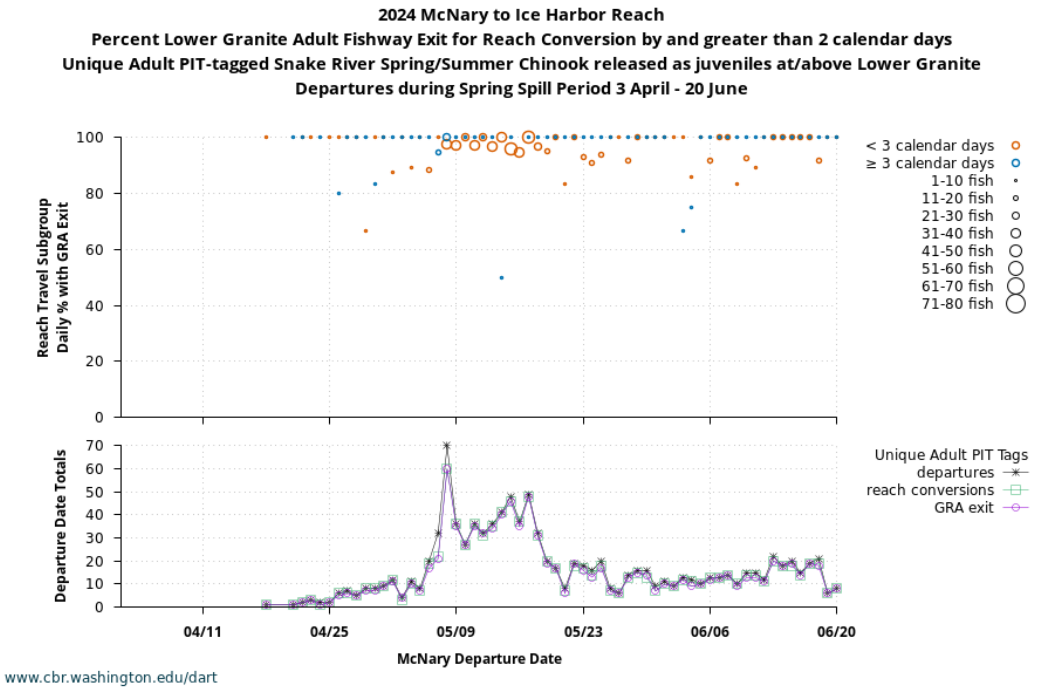


Figure 20. McNary to Ice Harbor 2024 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

Ice Harbor to Lower Monumental

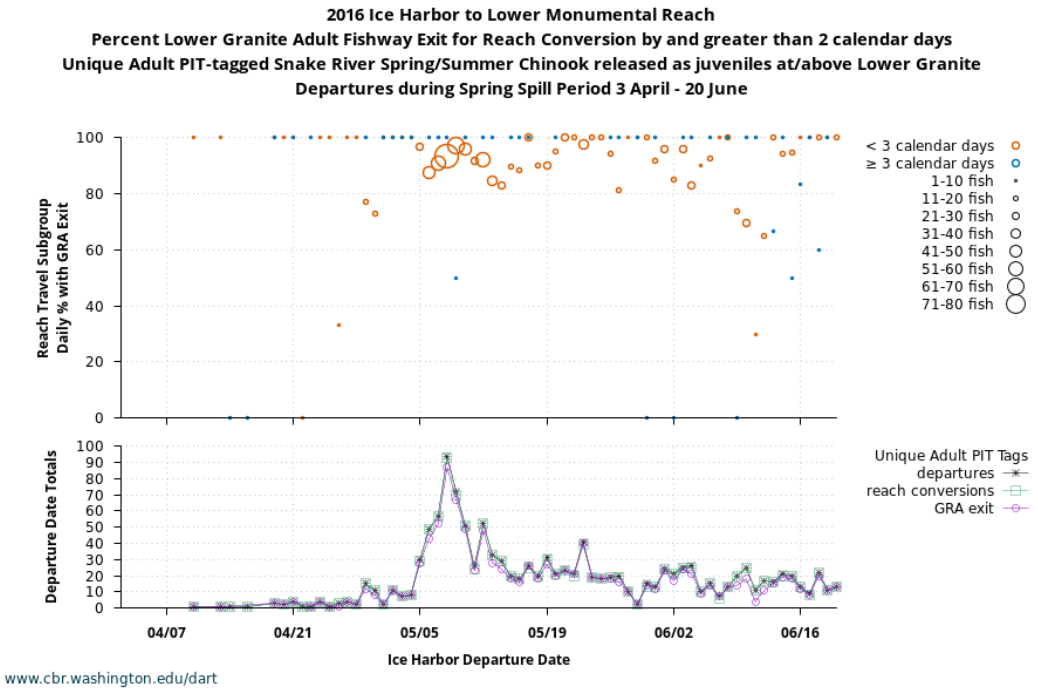


Figure 21. Ice Harbor to Lower Monumental 2016 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

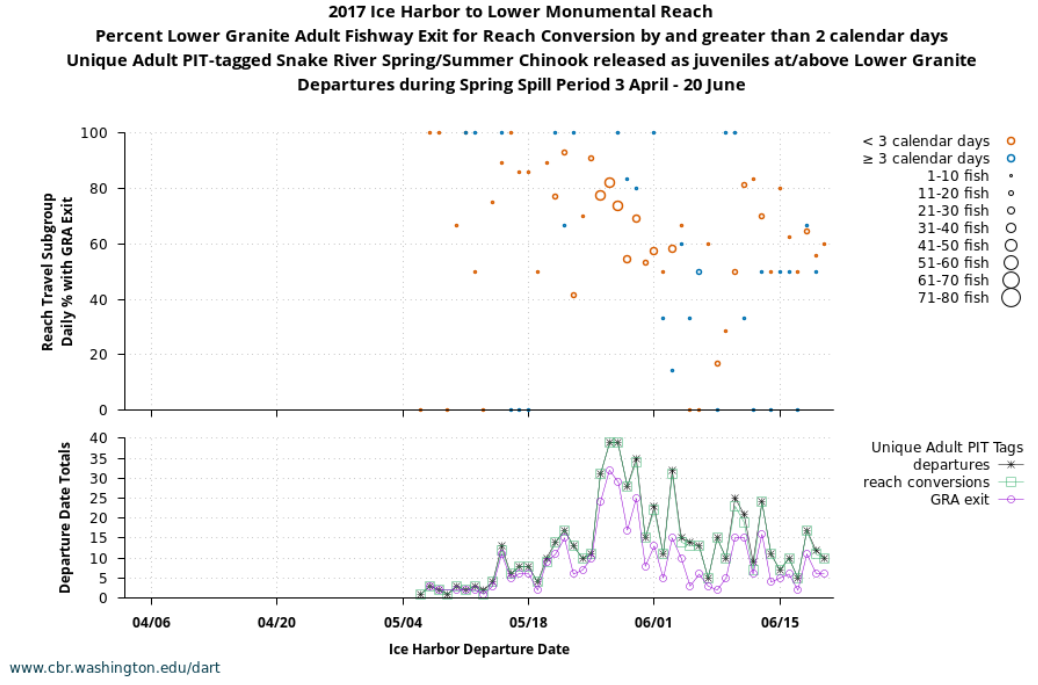


Figure 22. Ice Harbor to Lower Monumental 2017 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

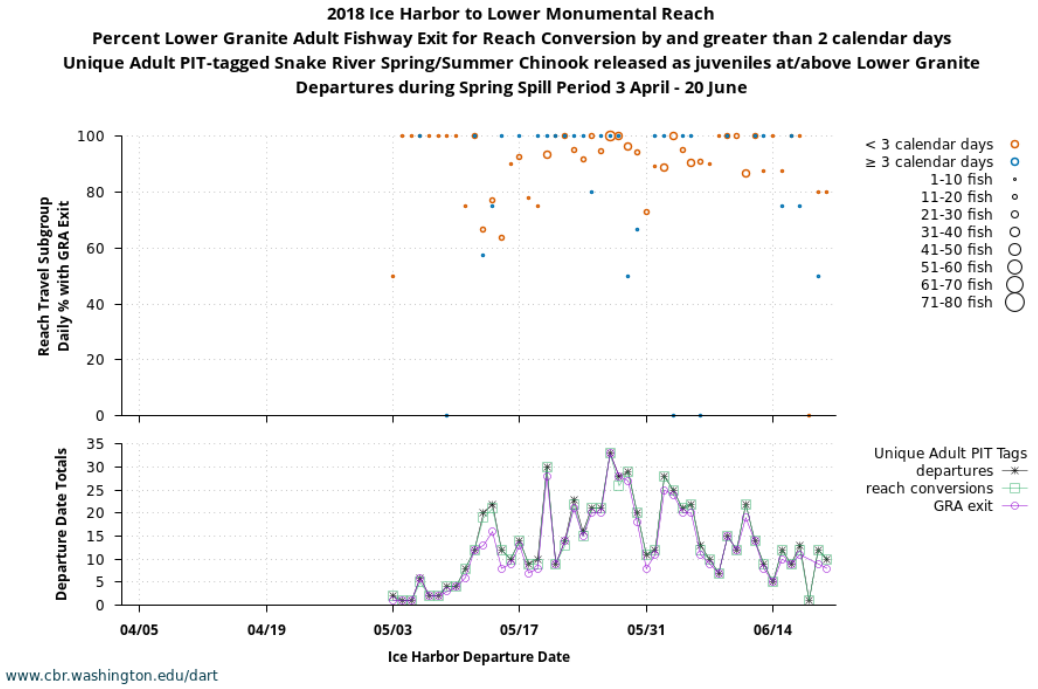


Figure 23. Ice Harbor to Lower Monumental 2018 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

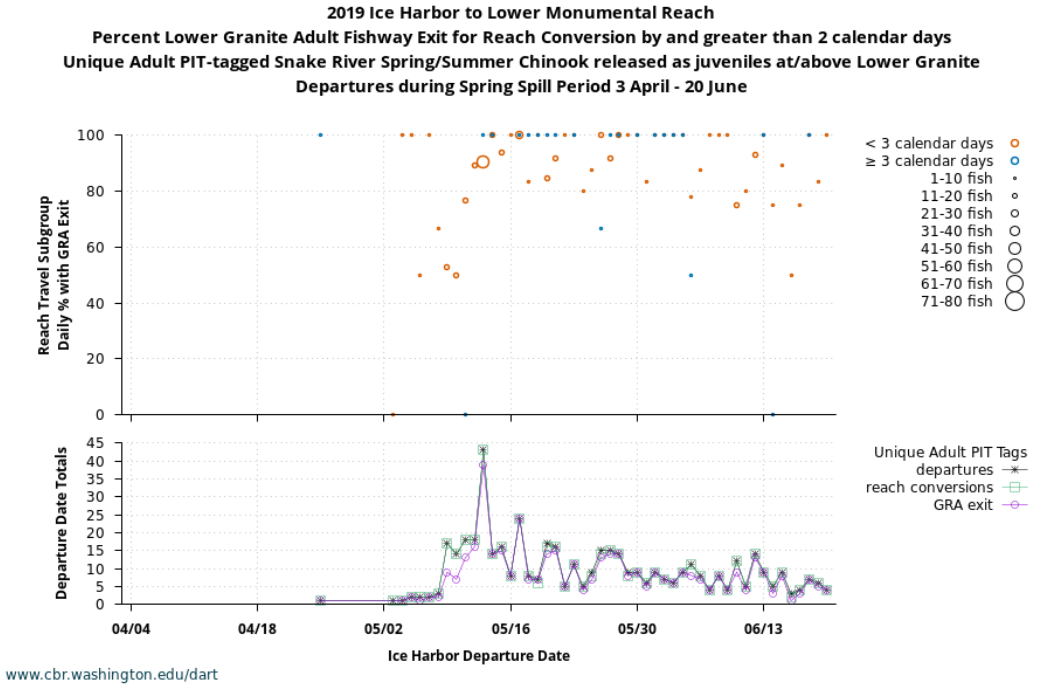


Figure 24. Ice Harbor to Lower Monumental 2019 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

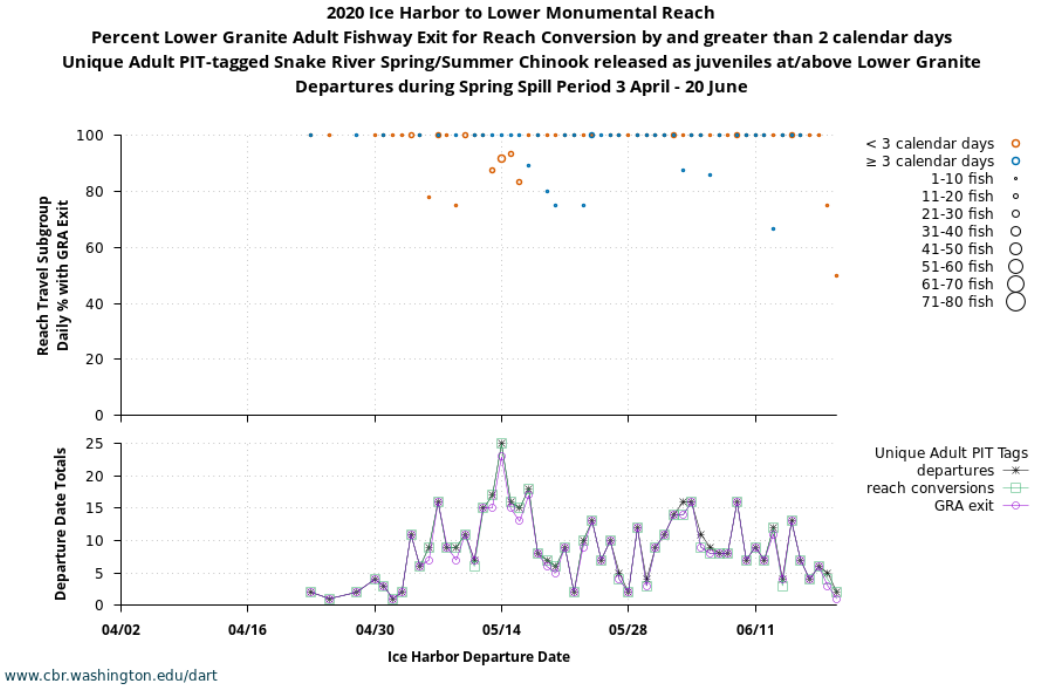


Figure 25. Ice Harbor to Lower Monumental 2020 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

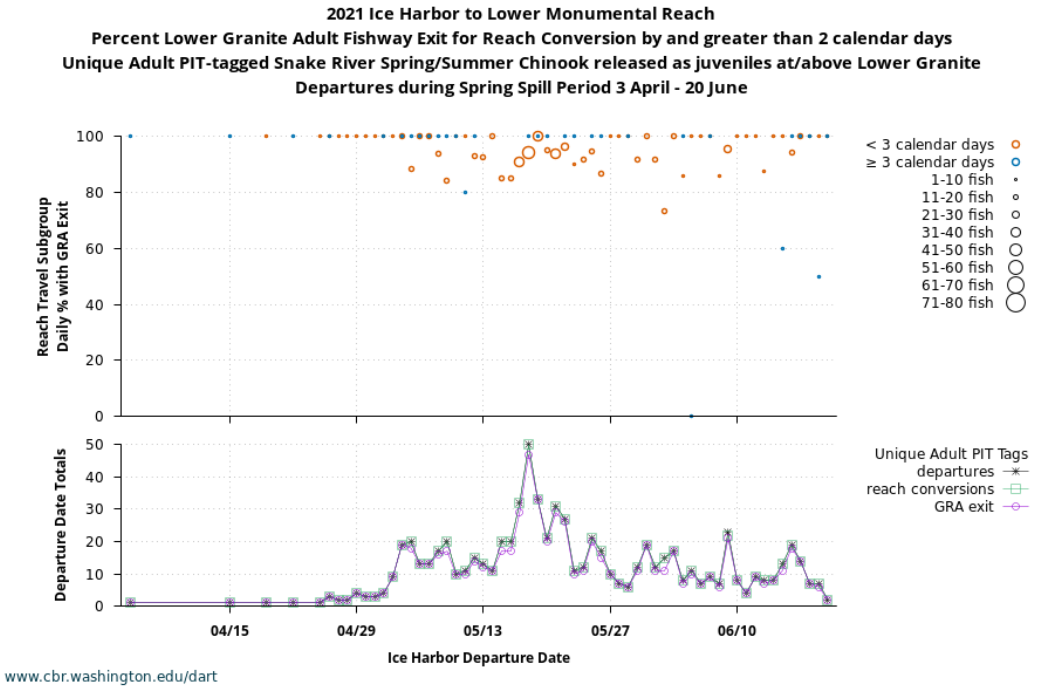


Figure 26. Ice Harbor to Lower Monumental 2021 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

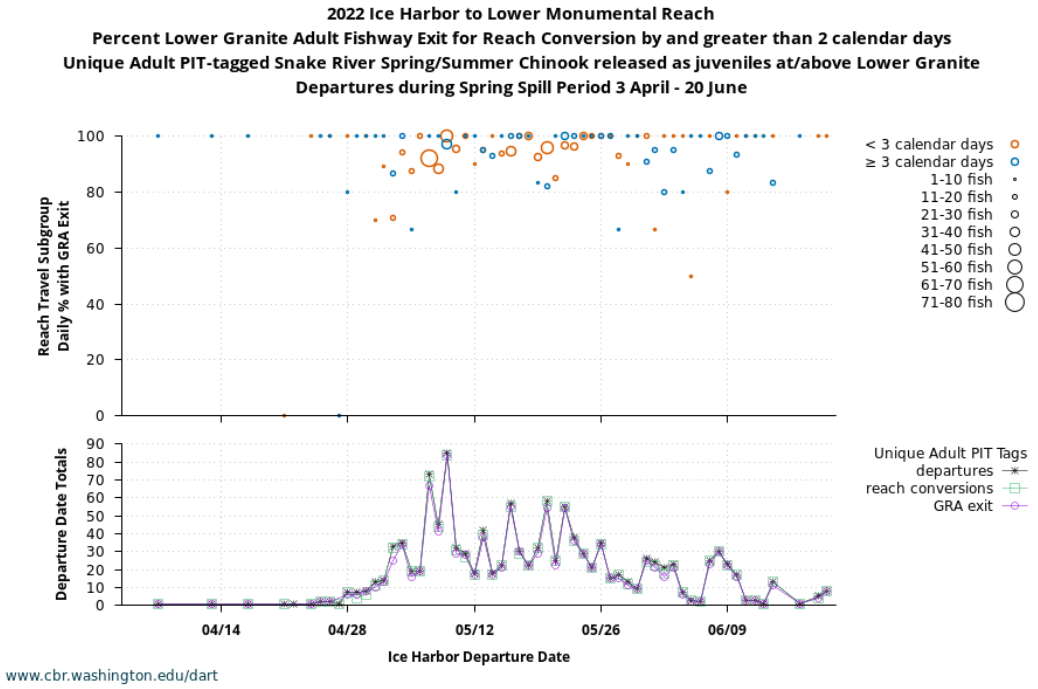


Figure 27. Ice Harbor to Lower Monumental 2022 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

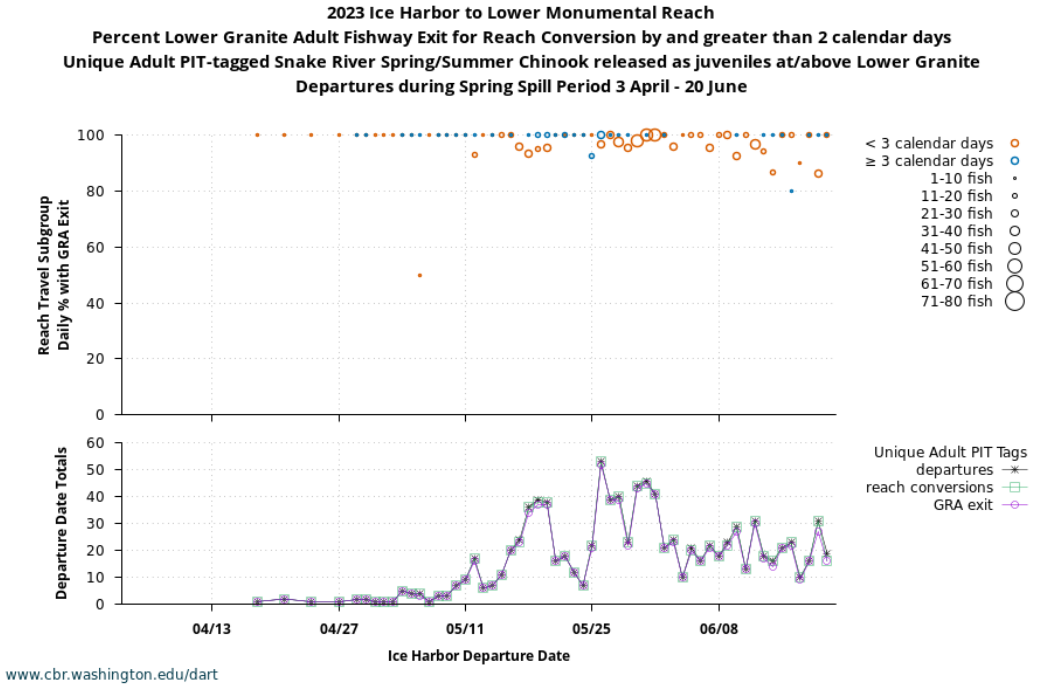


Figure 28. Ice Harbor to Lower Monumental 2023 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

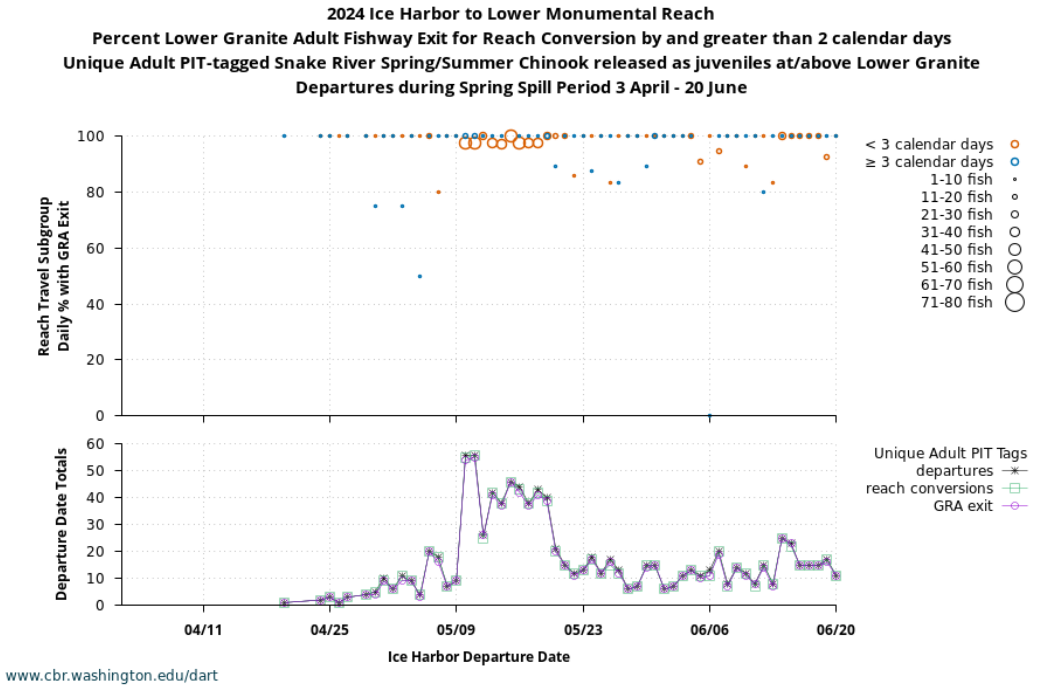


Figure 29. Ice Harbor to Lower Monumental 2024 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

Lower Monumental to Little Goose

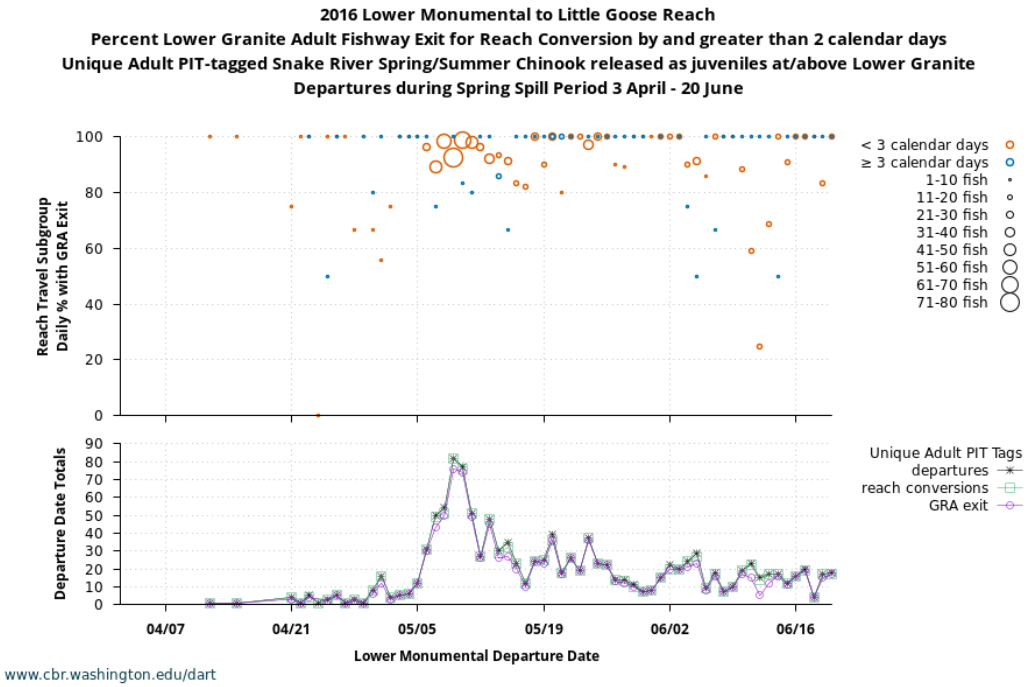


Figure 30. Lower Monumental to Little Goose 2016 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

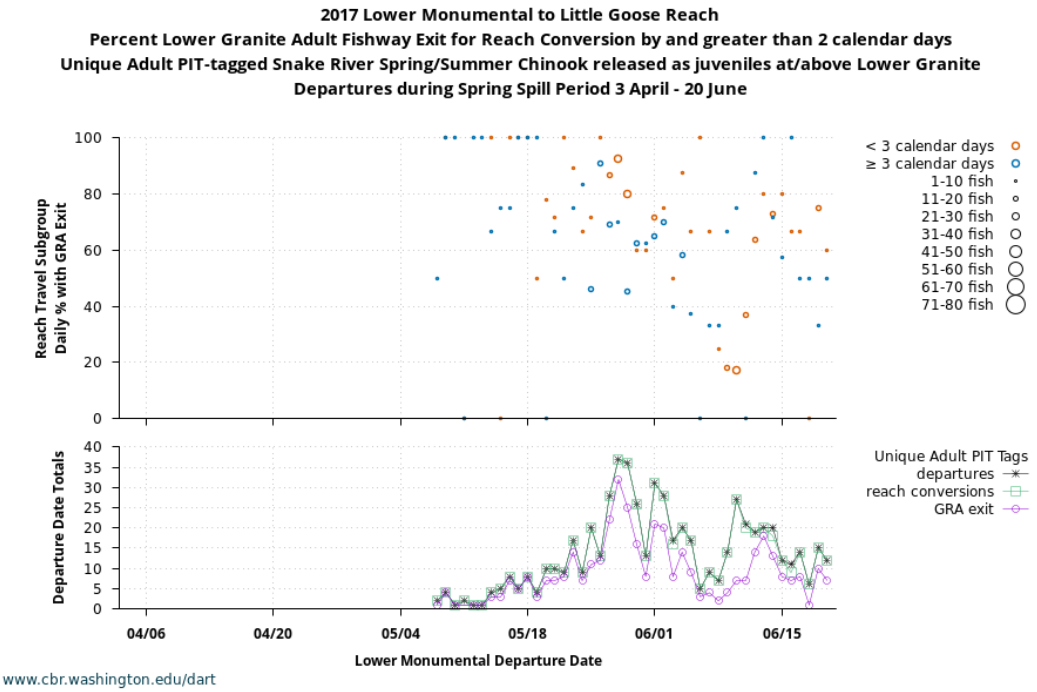


Figure 31. Lower Monumental to Little Goose 2017 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts

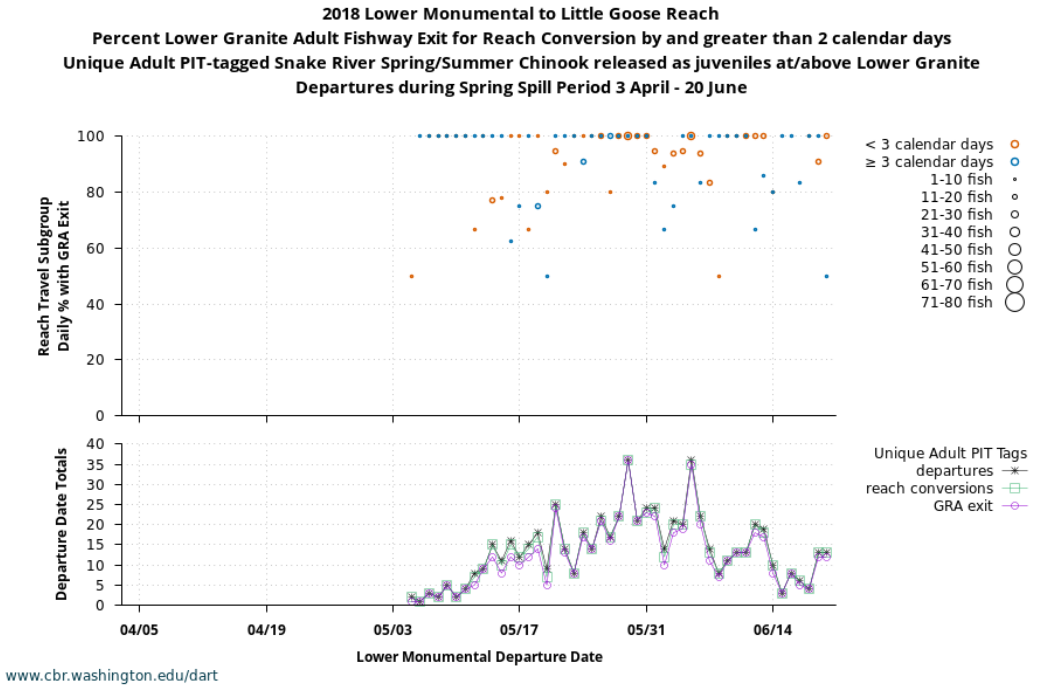


Figure 32. Lower Monumental to Little Goose 2018 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

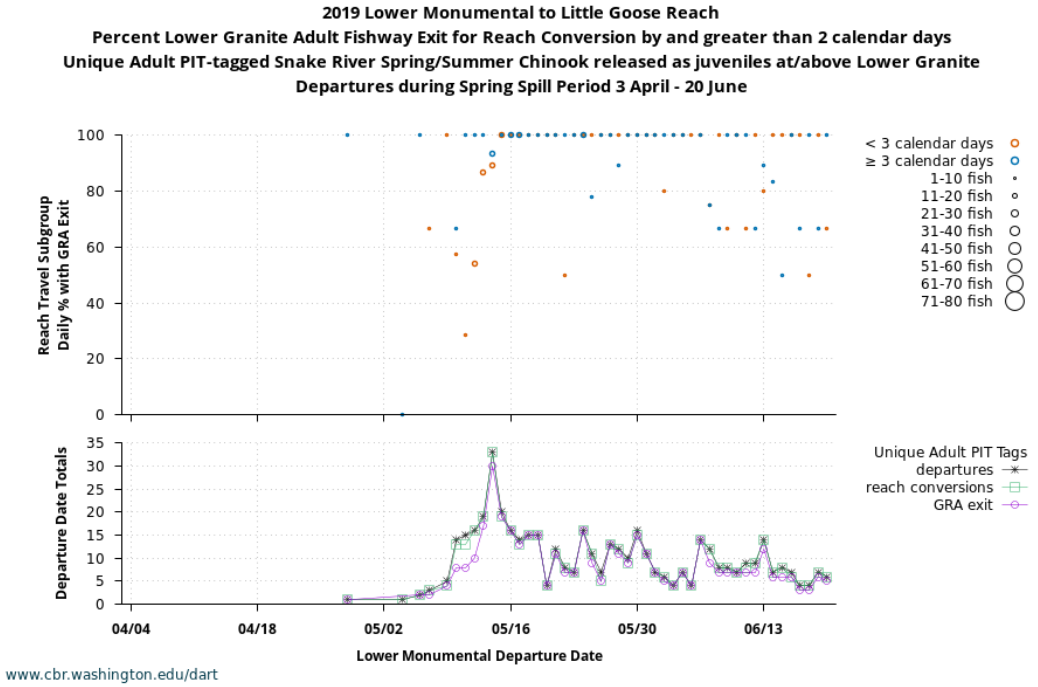


Figure 33. Lower Monumental to Little Goose 2019 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

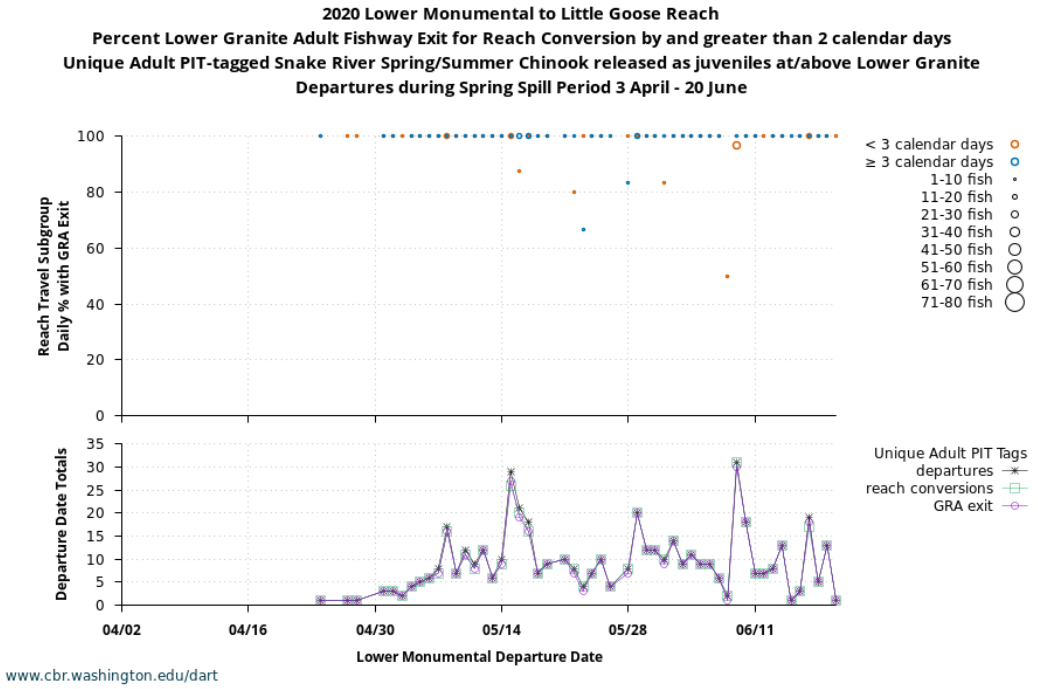


Figure 34. Lower Monumental to Little Goose 2020 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

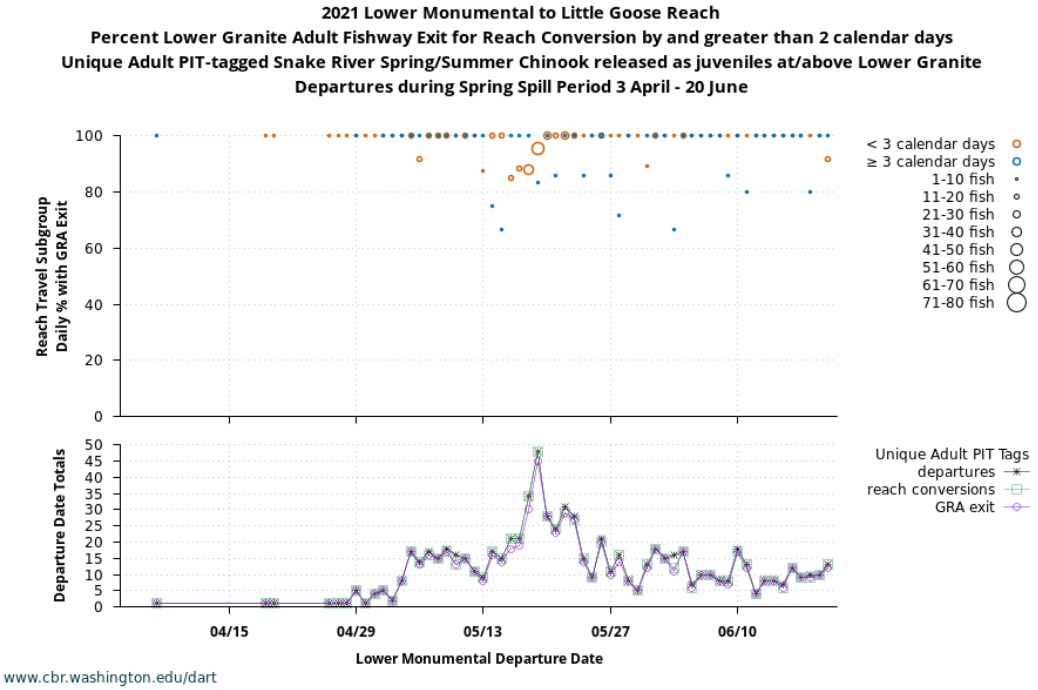


Figure 35. Lower Monumental to Little Goose 2021 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts

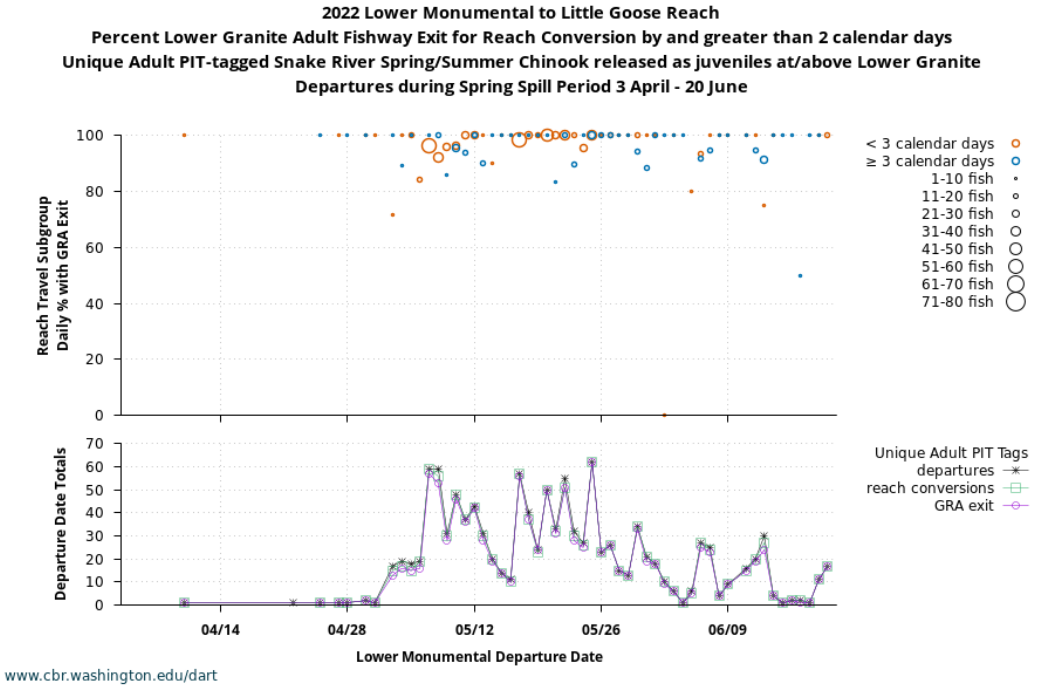


Figure 36. Lower Monumental to Little Goose 2022 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

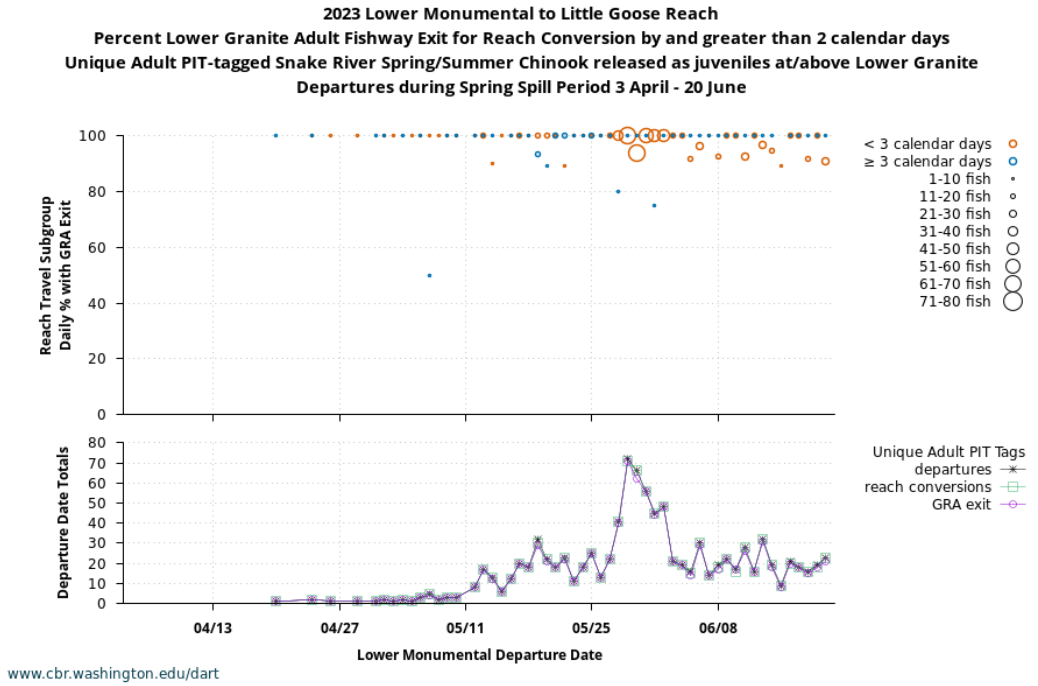


Figure 37. Lower Monumental to Little Goose 2023 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

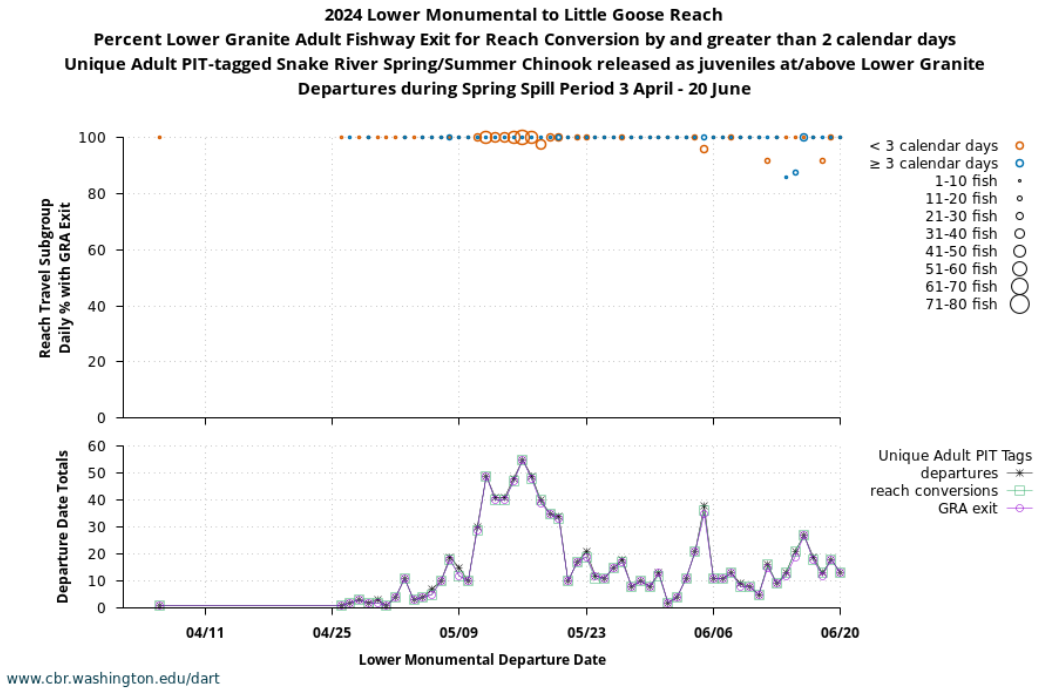


Figure 38. Lower Monumental to Little Goose 2024 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

Little Goose to Lower Granite

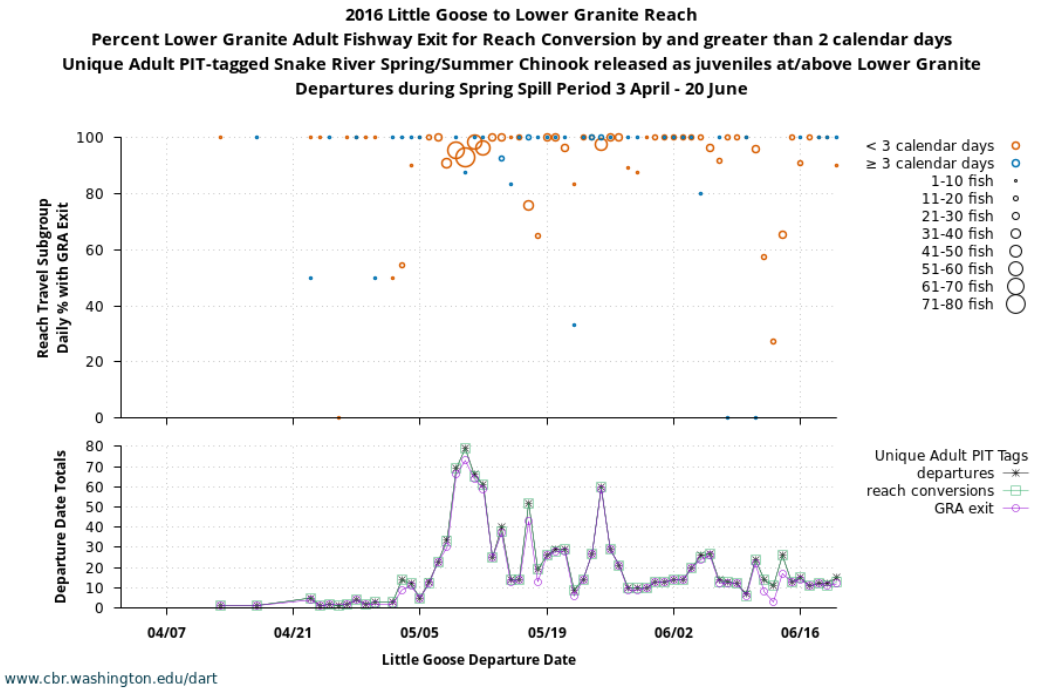


Figure 39. Little Goose to Lower Granite 2016 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

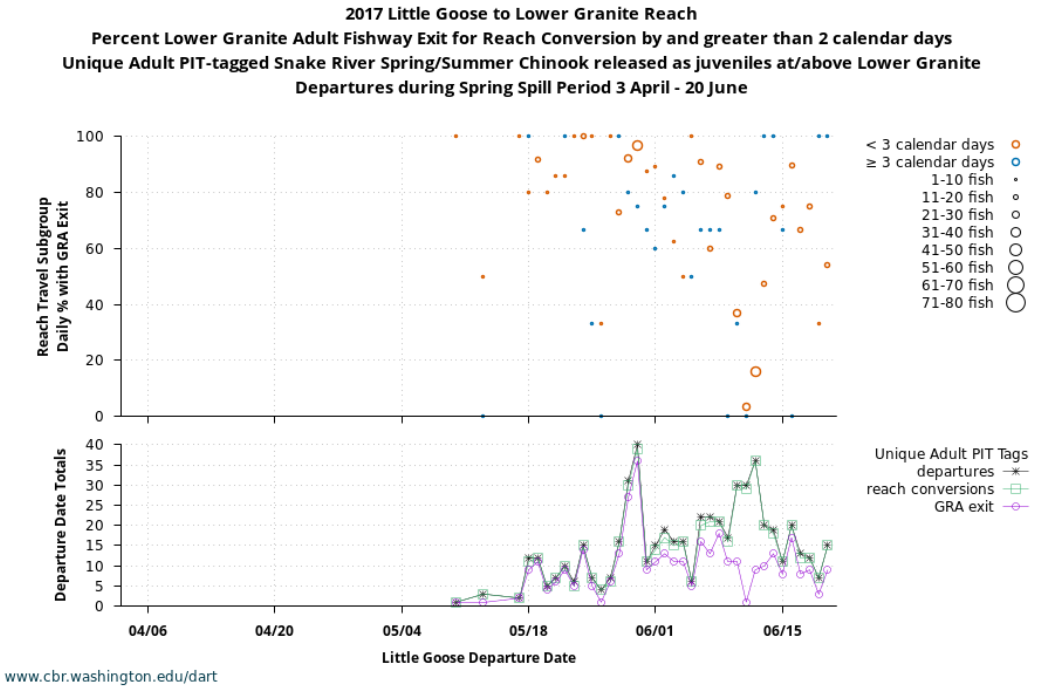


Figure 40. Little Goose to Lower Granite 2017 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

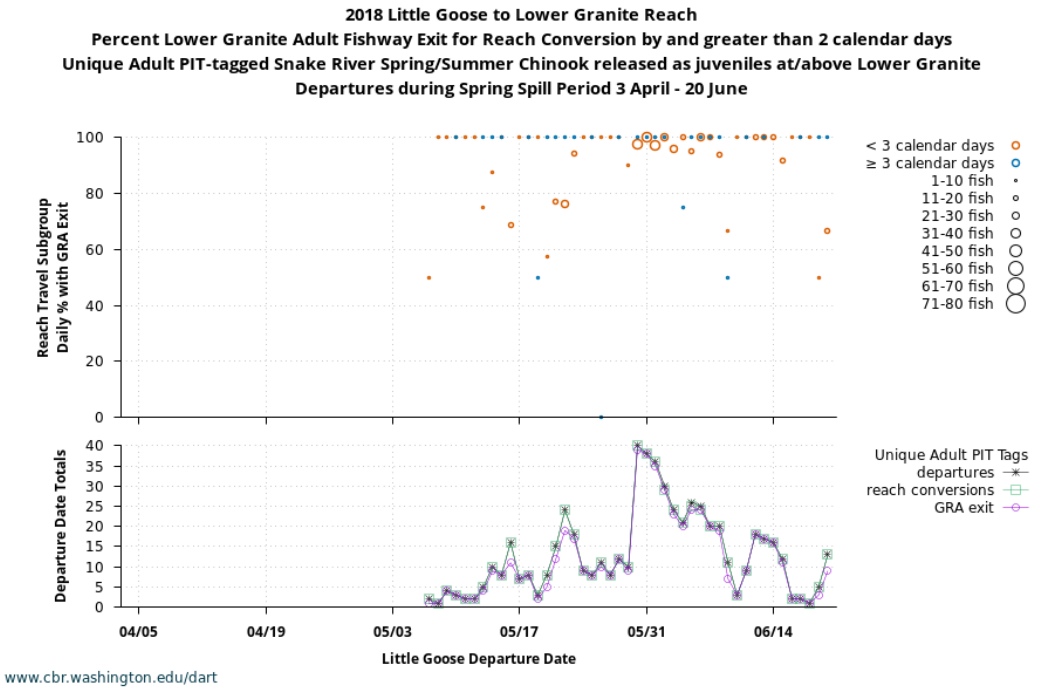


Figure 41. Little Goose to Lower Granite 2018 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

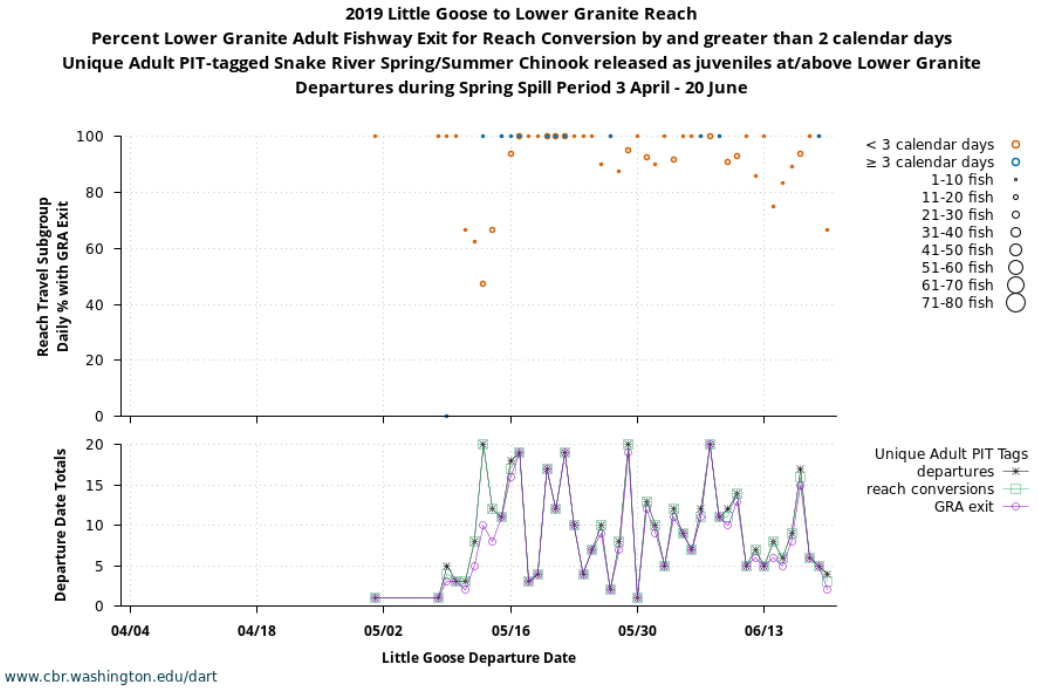


Figure 42. Little Goose to Lower Granite 2019 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

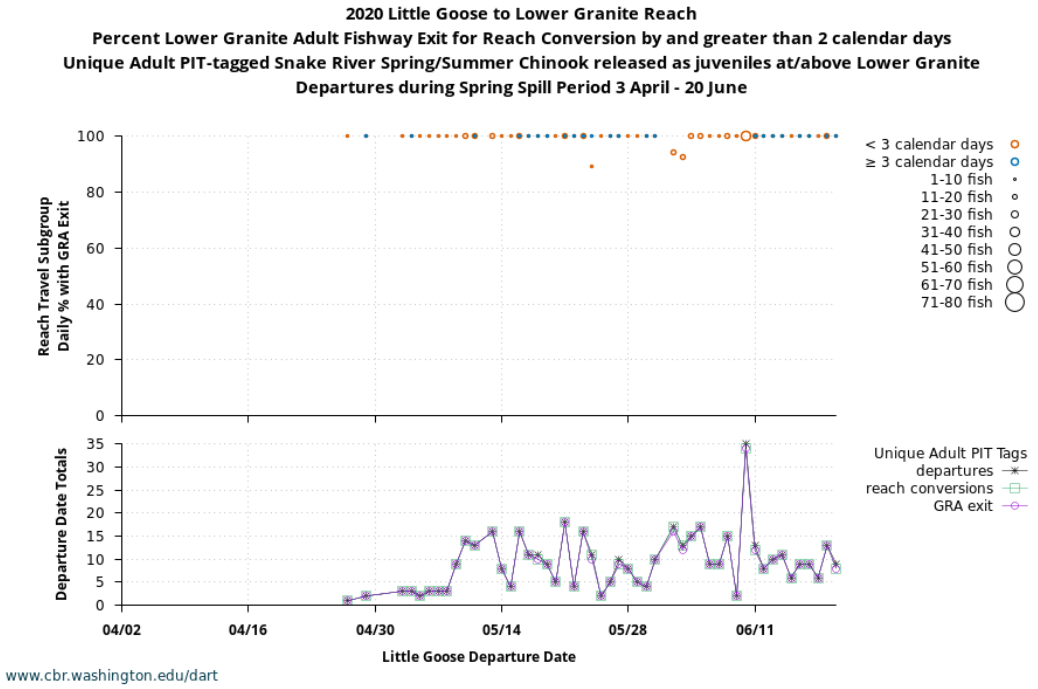


Figure 43. Little Goose to Lower Granite 2020 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

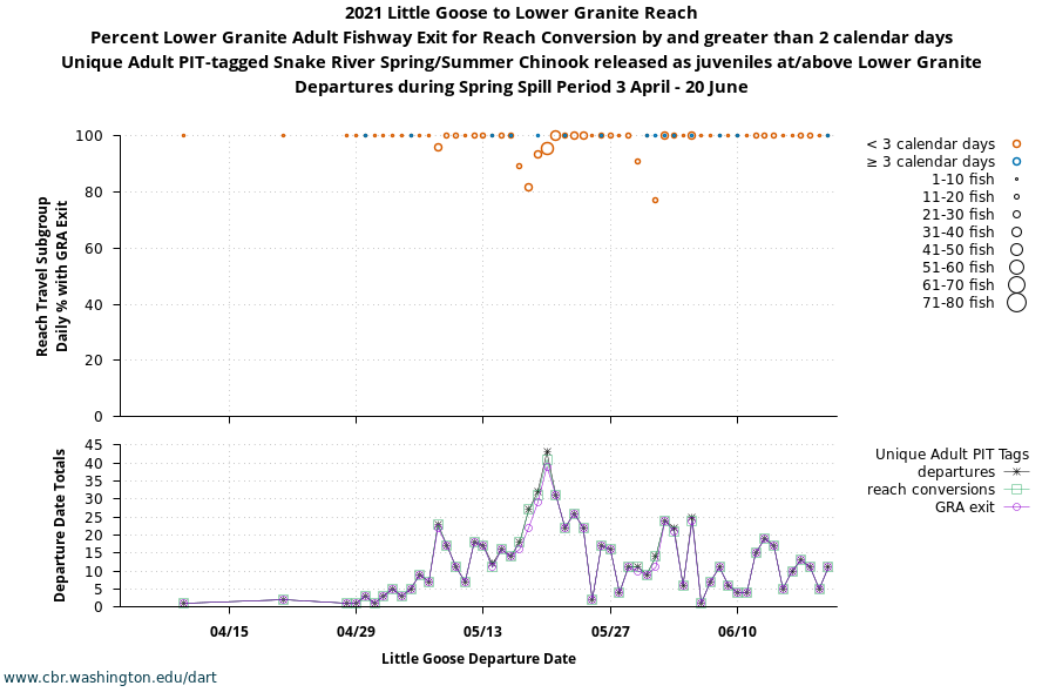


Figure 44. Little Goose to Lower Granite 2021 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

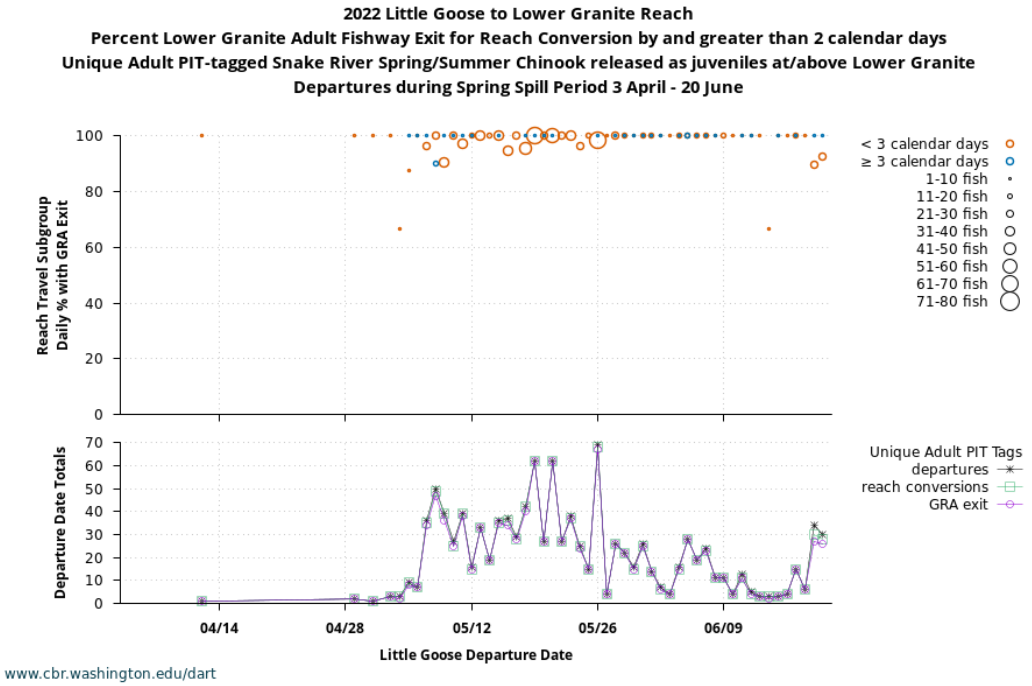


Figure 45. Little Goose to Lower Granite 2022 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

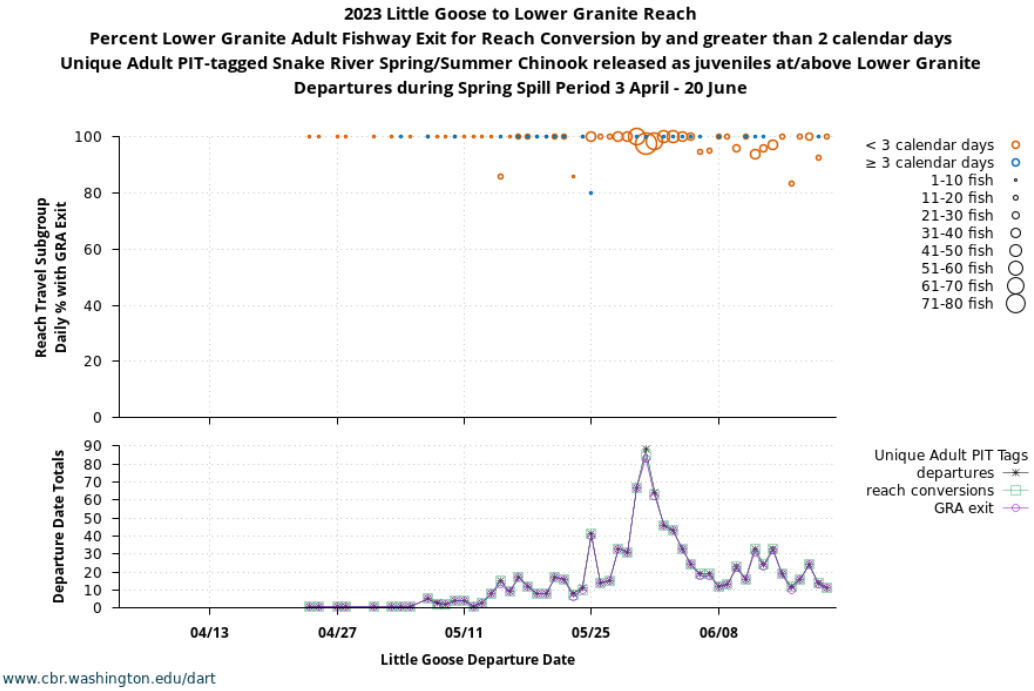


Figure 46. Little Goose to Lower Granite 2023 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

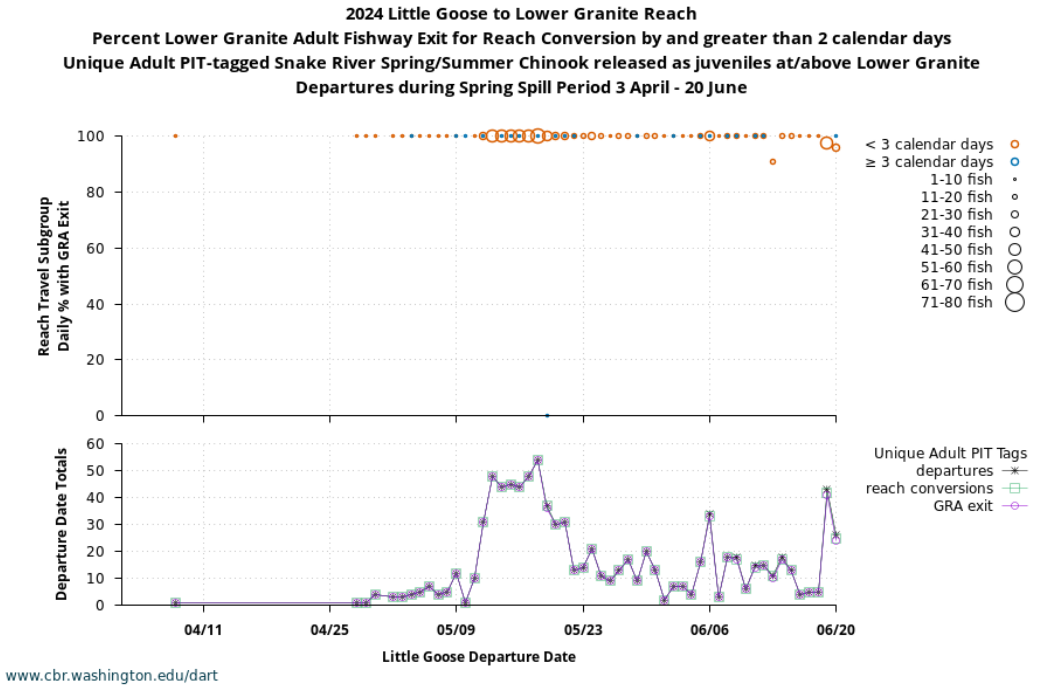


Figure 47. Little Goose to Lower Granite 2024 Travel Time Subgroups Daily Percent GRA Exit for 1-Day Departure Cohorts.

Appendix 3. Additional results from GLMM of probability of exiting GRA

Table 14. Model parameter estimates (Eq. 1) with reach travel times binned as < 3 days or ≥ 3 days.

	Estimate	Est.Error	l-95% CI	u-95% CI
Intercept_GOA_GRA	3.07	0.42	2.20	3.88
reachICH_LMA	-0.55	0.07	-0.70	-0.41
reachLMA_GOA	-0.18	0.08	-0.33	-0.03
reachMCA_ICH	-0.62	0.07	-0.77	-0.48
doyz	-0.23	0.06	-0.36	-0.11
CalTTcut_3d	-0.22	0.06	-0.33	-0.11
ascent_totz	-0.30	0.03	-0.36	-0.24
times_in_yearz	0.01	0.02	-0.04	0.05
reachICH_LMA:doyz	0.22	0.07	0.08	0.36
reachLMA_GOA:doyz	0.08	0.08	-0.07	0.24
reachMCA_ICH:doyz	0.23	0.07	0.08	0.38

Table 15. Model parameter estimates (Eq. 1) with reach travel times binned as < 4 days or ≥ 4 days.

	Estimate	Est.Error	l-95% CI	u-95% CI
Intercept_GOA_GRA	3.09	0.40	2.24	3.86
reachICH_LMA	-0.55	0.07	-0.70	-0.41
reachLMA_GOA	-0.19	0.08	-0.34	-0.02
reachMCA_ICH	-0.63	0.07	-0.78	-0.48
doyz	-0.23	0.06	-0.35	-0.12
CalTTcut_4d	-0.24	0.07	-0.38	-0.09
ascent_totz	-0.30	0.03	-0.36	-0.24
times_in_yearz	0.01	0.02	-0.04	0.05
reachICH_LMA:doyz	0.22	0.07	0.07	0.36
reachLMA_GOA:doyz	0.08	0.08	-0.08	0.23
reachMCA_ICH:doyz	0.23	0.07	0.09	0.36

Appendix 4. Dates when adult delay triggers would have occurred 2016-2024

Dates when 3-day and 4-day adult delay triggers would have occurred with 3-day or 1-day cohort data

Potential delay conditions are identified by “dots” in the DART Tool results main figure for running 3-day. The criteria for potential delay is that the Cumulative Arrival Percent of the 3-day cohort is less than the arrival percent criterion value by the "Average" travel days. The average travel days and arrival percent criterion are based on historical observations for each reach and population (Table 16).

Table 16. DART Tool Alert Criteria for Spring/Summer Chinook, juveniles released at/above Lower Granite, includes Unknown-run tagged at LWG in April and May in same year as release.

Lower Project	Upper Project	Date Range	Number of Reaches	Cumulative Arrival Percent	"Average" calendar days after departure to Arrive
McNary	Ice Harbor	4/3-6/20	1	50%	2
Ice Harbor	Lower Monumental	4/3-6/20	1	50%	2
Lower Monumental	Little Goose	4/3-6/20	1	50%	2
Little Goose	Lower Granite	4/3-6/20	1	50%	2

Here we apply the running 3-day criterion to both running 3-day and 1-day and track occurrences of consecutive days for identifying when a 3 and 4 “trigger” would have occurred in 2016-2024 for each focal reach regardless of management decisions and spill operations already implemented and unique to each historical year.

The “dot” date conditions are extracted from the DART Tool results. For each Snake River single reach, requests for years 2016-2024 were executed and dates were extracted from website output by a post-processing script created for this purpose.

The extracted “dot” dates files are included in the download package in the subfolder named “dotdates”, https://www.cbr.washington.edu/dart/cs/data/reachdist.zip. The package also includes the detailed ascent event with release and detection information files for each year and Snake River reach. All “dot” dates are fully represented in the following tables.

McNary to Ice Harbor

Table 17. McNary to Ice Harbor "Dot" Dates for Running 3-day Cumulative Cohort and 1-day Cohort, 2016-2024.

Year	"Dot" Date	Running 3-day Cohort (minimum 7 fish)				1-Day Cohort (no minimum)			
		Cumulative Percent	Consecutive Day Count	3 Dots	4 Dots	Cumulative Percent	Consecutive Day Count	3 Dots	4 Dots
2016	4/13/2016			0	0	0	1	0	0
2016	4/14/2016			0	0	0	2	0	0
2016	4/16/2016			0	0	0	1	0	0
2016	4/21/2016			0	0	0	1	0	0
2016	4/29/2016			0	0	37.5	1	0	0
2016	5/27/2016			0	0	37.5	1	0	0
2016	**Total**			**0**	**0**			**0**	**0**
2017	5/11/2017			0	0	20	1	0	0
2017	5/12/2017	31.4	1	0	0	21.1	2	0	0
2017	5/13/2017	30.8	2	0	0			0	0
2017	5/14/2017	33.3	3	1	0	30	1	0	0
2017	5/17/2017			0	0	33.3	1	0	0
2017	5/31/2017			0	0	36	1	0	0
2017	6/4/2017			0	0	43.5	1	0	0
2017	6/5/2017	43.4	1	0	0	28.6	2	0	0
2017	6/6/2017	40.8	2	0	0			0	0
2017	6/7/2017	36.6	3	1	0	33.3	1	0	0
2017	6/8/2017	40.9	4	1	1	41.2	2	0	0
2017	6/9/2017	46.2	5	1	1			0	0
2017	6/10/2017	47.8	6	1	1	33.3	1	0	0
2017	6/15/2017			0	0	45.5	1	0	0
2017	**Total**			**5**	**3**			**0**	**0**
2018	5/3/2018			0	0	0	1	0	0
2018	5/8/2018			0	0	33.3	1	0	0
2018	5/15/2018			0	0	47.4	1	0	0
2018	5/16/2018			0	0	38.5	2	0	0
2018	5/17/2018	46.3	1	0	0			0	0
2018	5/30/2018			0	0	34.8	1	0	0
2018	5/31/2018	42.2	1	0	0	29.4	2	0	0
2018	6/1/2018	47.5	2	0	0			0	0
2018	6/12/2018			0	0	40	1	0	0
2018	**Total**			**0**	**0**			**0**	**0**
2019	4/18/2019			0	0	0	1	0	0
2019	4/27/2019			0	0	0	1	0	0
2019	5/23/2019			0	0	44.4	1	0	0
2019	6/7/2019			0	0	40	1	0	0

2019	**Total**			**0**	**0**			**0**	**0**
2020	5/20/2020	42.4	1	0	0	25	1	0	0
2020	5/21/2020	35.3	2	0	0	27.3	2	0	0
2020	5/22/2020	32.4	3	1	0			0	0
2020	5/23/2020	40.6	4	1	1	45.5	1	0	0
2020	5/25/2020	41.9	1	0	0	11.1	1	0	0
2020	5/26/2020	32.1	2	0	0	12.5	2	0	0
2020	5/27/2020	15	3	1	0	33.3	3	1	0
2020	5/28/2020	33.3	4	1	1			0	0
2020	5/30/2020			0	0	42.9	1	0	0
2020	6/1/2020			0	0	44.4	1	0	0
2020	**Total**			**4**	**2**			**1**	**0**
2021	4/23/2021			0	0	0	1	0	0
2021	**Total**			**0**	**0**			**0**	**0**
2022	4/8/2022			0	0	0	1	0	0
2022	4/9/2022			0	0	0	2	0	0
2022	4/21/2022			0	0	0	1	0	0
2022	4/22/2022			0	0	0	2	0	0
2022	4/23/2022			0	0	33.3	3	1	0
2022	4/24/2022	28.6	1	0	0			0	0
2022	5/17/2022			0	0	44.9	1	0	0
2022	5/28/2022			0	0	42.9	1	0	0
2022	5/29/2022	47.7	1	0	0			0	0
2022	6/2/2022			0	0	34.3	1	0	0
2022	6/3/2022	38.2	1	0	0	9.5	2	0	0
2022	6/4/2022	18.4	2	0	0	0	3	1	0
2022	6/5/2022	13.3	3	1	0	31.6	4	1	1
2022	6/6/2022	20	4	1	1	31.3	5	1	1
2022	6/7/2022	32.8	5	1	1	34.5	6	1	1
2022	6/8/2022	35.7	6	1	1	40	7	1	1
2022	6/9/2022	28.2	7	1	1	8.3	8	1	1
2022	6/10/2022	17.3	8	1	1	3.8	9	1	1
2022	6/11/2022	4.7	9	1	1	0	10	1	1
2022	6/12/2022	2	10	1	1	0	11	1	1
2022	6/13/2022	0	11	1	1	0	12	1	1
2022	6/14/2022	0	12	1	1	0	13	1	1
2022	6/15/2022	0	13	1	1	0	14	1	1
2022	6/16/2022	0	14	1	1	0	15	1	1
2022	6/17/2022	0	15	1	1	0	16	1	1
2022	6/18/2022	0	16	1	1	0	17	1	1
2022	6/19/2022			0	0	41.7	18	1	1
2022	**Total**			**14**	**13**			**17**	**15**
2023	4/9/2023			0	0	0	1	0	0

2023	4/12/2023			0	0	0	1	0	0
2023	5/2/2023			0	0	42.9	1	0	0
2023	5/5/2023	43.8	1	0	0	28.6	1	0	0
2023	5/6/2023	40	2	0	0			0	0
2023	5/7/2023	27.8	3	1	0	0	1	0	0
2023	5/8/2023	28.1	4	1	1	28.6	2	0	0
2023	5/9/2023	25.7	5	1	1	33.3	3	1	0
2023	5/10/2023	34.3	6	1	1			0	0
2023	5/11/2023	38.9	7	1	1	25	1	0	0
2023	5/12/2023	37.5	8	1	1	28.6	2	0	0
2023	5/13/2023	35.3	9	1	1			0	0
2023	5/20/2023			0	0	39.1	1	0	0
2023	5/21/2023	37.9	1	0	0	16.3	2	0	0
2023	5/22/2023	23.9	2	0	0	10.7	3	1	0
2023	5/23/2023	12.6	3	1	0	10	4	1	1
2023	5/24/2023	23.5	4	1	1	42.6	5	1	1
2023	5/25/2023	37.6	5	1	1			0	0
2023	5/27/2023	47.5	1	0	0	30.3	1	0	0
2023	5/28/2023	47.4	2	0	0			0	0
2023	**Total**			**10**	**8**			**4**	**2**
2024	4/21/2024			0	0	0	1	0	0
2024	4/24/2024			0	0	0	1	0	0
2024	4/26/2024	30	1	0	0	16.7	1	0	0
2024	4/27/2024	33.3	2	0	0	28.6	2	0	0
2024	4/28/2024	27.8	3	1	0	40	3	1	0
2024	4/29/2024	35	4	1	1	37.5	4	1	1
2024	4/30/2024	33.3	5	1	1	25	5	1	1
2024	5/1/2024	32	6	1	1	33.3	6	1	1
2024	5/2/2024	44.8	7	1	1			0	0
2024	5/3/2024			0	0	40	1	0	0
2024	5/7/2024	44.3	1	0	0	12.5	1	0	0
2024	5/8/2024	46.8	2	0	0			0	0
2024	5/31/2024			0	0	33.3	1	0	0
2024	6/1/2024	48.6	1	0	0			0	0
2024	**Total**			**5**	**4**			**4**	**3**

Ice Harbor to Lower Monumental

Table 18. Ice Harbor to Lower Monumental "Dot" Dates for Running 3-day Cohort and 1-day Cohort, 2016-2024.

Year	"Dot" Date	Running 3-day Cohort (minimum 7 fish)				1-Day Cohort (no minimum)			
		Cumulative Percent	Consecutive Day Count	3 Dots	4 Dots	Cumulative Percent	Consecutive Day Count	3 Dots	4 Dots
2016	4/14/2016			0	0	0	1	0	0
2016	4/16/2016			0	0	0	1	0	0
2016	4/23/2016			0	0	0	1	0	0
2016	**Total**			**0**	**0**			**0**	**0**
2017	5/11/2017			0	0	33.3	1	0	0
2017	5/13/2017	44.4	1	0	0			0	0
2017	6/5/2017			0	0	26.7	1	0	0
2017	6/6/2017	31.1	1	0	0	7.7	2	0	0
2017	6/7/2017	30.3	2	0	0			0	0
2017	**Total**			**0**	**0**			**0**	**0**
2018	**Total**			**0**	**0**			**0**	**0**
2019	4/25/2019			0	0	0	1	0	0
2019	**Total**			**0**	**0**			**0**	**0**
2020	4/22/2020			0	0	0	1	0	0
2020	4/28/2020			0	0	0	1	0	0
2020	5/17/2020			0	0	45	1	0	0
2020	5/18/2020	48.9	1	0	0	20	2	0	0
2020	5/19/2020	35.1	2	0	0	28.6	3	1	0
2020	5/20/2020	24	3	1	0	25	4	1	1
2020	5/21/2020	37.5	4	1	1			0	0
2020	5/22/2020	42.1	5	1	1			0	0
2020	5/24/2020	36	1	0	0	15.4	1	0	0
2020	5/25/2020	25	2	0	0	0	2	0	0
2020	5/26/2020	9.1	3	1	0	9.1	3	1	0
2020	5/27/2020	12	4	1	1	40	4	1	1
2020	5/28/2020	27.8	5	1	1			0	0
2020	5/30/2020			0	0	33.3	1	0	0
2020	6/3/2020			0	0	37.5	1	0	0
2020	6/4/2020			0	0	47.1	2	0	0
2020	6/5/2020	35.6	1	0	0	16.7	3	1	0
2020	6/6/2020	28.9	2	0	0	11.1	4	1	1
2020	6/7/2020	33.3	3	1	0			0	0
2020	6/14/2020			0	0	25	1	0	0
2020	**Total**			**7**	**4**			**6**	**3**
2021	4/4/2021			0	0	0	1	0	0
2021	4/15/2021			0	0	0	1	0	0

2021	4/22/2021			0	0	0	1	0	0
2021	**Total**			**0**	**0**			**0**	**0**
2022	4/7/2022			0	0	0	1	0	0
2022	4/13/2022			0	0	0	1	0	0
2022	4/17/2022			0	0	0	1	0	0
2022	4/22/2022			0	0	0	1	0	0
2022	4/25/2022			0	0	0	1	0	0
2022	4/27/2022			0	0	0	1	0	0
2022	4/28/2022	30	1	0	0	28.6	2	0	0
2022	4/29/2022	12.5	2	0	0	0	3	1	0
2022	4/30/2022	13	3	1	0	12.5	4	1	1
2022	5/1/2022	37.9	4	1	1			0	0
2022	5/4/2022			0	0	48.6	1	0	0
2022	5/12/2022			0	0	45.5	1	0	0
2022	5/13/2022			0	0	42.2	2	0	0
2022	5/14/2022	35.6	1	0	0	13	3	1	0
2022	5/15/2022	40.9	2	0	0			0	0
2022	5/16/2022	49.6	3	1	0			0	0
2022	5/17/2022			0	0	38.5	1	0	0
2022	5/26/2022			0	0	40.5	1	0	0
2022	5/27/2022	45.3	1	0	0	25	2	0	0
2022	5/28/2022	46.5	2	0	0			0	0
2022	5/31/2022			0	0	48.1	1	0	0
2022	6/1/2022	38.7	1	0	0	12.5	2	0	0
2022	6/2/2022	26.4	2	0	0	14.3	3	1	0
2022	6/3/2022	11.6	3	1	0	8.3	4	1	1
2022	6/4/2022	13.5	4	1	1	28.6	5	1	1
2022	6/5/2022	17.6	5	1	1			0	0
2022	6/6/2022	30.8	6	1	1	0	1	0	0
2022	6/7/2022	34.4	7	1	1	34.6	2	0	0
2022	6/8/2022	15	8	1	1	0	3	1	0
2022	6/9/2022	17.3	9	1	1	20.8	4	1	1
2022	6/10/2022	9.6	10	1	1	11.1	5	1	1
2022	6/11/2022	17.8	11	1	1	33.3	6	1	1
2022	6/12/2022	16.7	12	1	1	33.3	7	1	1
2022	6/13/2022	25	13	1	1	0	8	1	1
2022	6/14/2022	10.5	14	1	1	7.1	9	1	1
2022	6/15/2022	6.3	15	1	1			0	0
2022	6/16/2022	7.1	16	1	1			0	0
2022	6/17/2022			0	0	0	1	0	0
2022	**Total**			**17**	**14**			**13**	**9**
2023	5/8/2023			0	0	33.3	1	0	0
2023	5/9/2023	37.5	1	0	0	25	2	0	0

2023	5/10/2023	37.5	2	0	0	44.4	3	1	0
2023	5/19/2023			0	0	47.6	1	0	0
2023	5/22/2023			0	0	36.8	1	0	0
2023	5/23/2023	48.9	1	0	0			0	0
2023	5/24/2023	45	2	0	0	44.4	1	0	0
2023	5/25/2023	45.5	3	1	0	39.1	2	0	0
2023	**Total**			**1**	**0**			**1**	**0**
2024	4/20/2024			0	0	0	1	0	0
2024	4/25/2024			0	0	25	1	0	0
2024	4/26/2024	42.9	1	0	0			0	0
2024	4/29/2024	42.9	1	0	0	25	1	0	0
2024	4/30/2024	22.2	2	0	0	20	2	0	0
2024	5/1/2024	42.1	3	1	0			0	0
2024	5/3/2024			0	0	25	1	0	0
2024	5/5/2024	37.9	1	0	0	25	1	0	0
2024	5/8/2024			0	0	42.9	1	0	0
2024	5/23/2024			0	0	46.2	1	0	0
2024	5/26/2024	48.9	1	0	0	35.3	1	0	0
2024	5/27/2024	46.5	2	0	0	42.9	2	0	0
2024	5/28/2024	43.2	3	1	0			0	0
2024	5/29/2024	48.1	4	1	1	42.9	1	0	0
2024	5/30/2024	46.4	5	1	1	40	2	0	0
2024	5/31/2024	29.7	6	1	1	13.3	3	1	0
2024	6/1/2024	30.6	7	1	1			0	0
2024	6/2/2024	39.3	8	1	1			0	0
2024	**Total**			**7**	**5**			**1**	**0**

Lower Monumental to Little Goose

Table 19. Little Goose to Lower Granite "Dot" Dates for Running 3-day Cohort and 1-day Cohort, 2016-2024.

Year	"Dot" Date	Running 3-day Cohort (minimum 7 fish)				1-day Cohort (no minimum)			
		Cumulative Percent	Consecutive Day Count	3 Dots	4 Dots	Cumulative Percent	Consecutive Day Count	3 Dots	4 Dots
2016	4/25/2016			0	0	33.3	1	0	0
2016	4/29/2016			0	0	0	1	0	0
2016	4/30/2016	42.9	1	0	0	37.5	2	0	0
2016	5/1/2016	46.2	2	0	0			0	0
2016	5/14/2016			0	0	45.5	1	0	0
2016	5/21/2016			0	0	27.8	1	0	0
2016	**Total**			**0**	**0**			**0**	**0**
2017	5/8/2017			0	0	0	1	0	0
2017	5/9/2017			0	0	25	2	0	0
2017	5/10/2017	14.3	1	0	0	0	3	1	0
2017	5/11/2017	25	2	0	0	33.3	4	1	1
2017	5/12/2017			0	0	0	5	1	1
2017	5/13/2017			0	0	0	6	1	1
2017	5/14/2017			0	0	25	7	1	1
2017	5/15/2017	20	1	0	0	20	8	1	1
2017	5/16/2017	31.6	2	0	0	40	9	1	1
2017	5/17/2017	42.9	3	1	0			0	0
2017	5/19/2017			0	0	40	1	0	0
2017	5/24/2017			0	0	33.3	1	0	0
2017	5/25/2017	40.4	1	0	0	33.3	2	0	0
2017	5/26/2017	27.9	2	0	0	15.4	3	1	0
2017	5/27/2017	38.7	3	1	0			0	0
2017	5/30/2017			0	0	35.7	1	0	0
2017	5/31/2017	48.2	1	0	0	29.4	2	0	0
2017	6/1/2017	39	2	0	0	46.9	3	1	0
2017	6/2/2017	35.9	3	1	0	27.6	4	1	1
2017	6/3/2017	36.7	4	1	1	33.3	5	1	1
2017	6/4/2017	32.4	5	1	1	38.1	6	1	1
2017	6/5/2017	40.4	6	1	1			0	0
2017	6/6/2017	45.5	7	1	1			0	0
2017	6/7/2017	46.9	8	1	1	33.3	1	0	0
2017	6/8/2017	45.5	9	1	1			0	0
2017	6/13/2017			0	0	47.6	1	0	0
2017	6/15/2017	47.3	1	0	0	38.5	1	0	0
2017	6/16/2017	48.9	2	0	0			0	0
2017	6/17/2017	44.7	3	1	0	42.9	1	0	0

2017	**Total**			**10**	**6**			**12**	**9**
2018	5/6/2018			0	0	0	1	0	0
2018	5/16/2018			0	0	43.8	1	0	0
2018	5/17/2018	47.6	1	0	0	30.8	2	0	0
2018	5/18/2018	36.2	2	0	0	33.3	3	1	0
2018	5/19/2018	30.6	3	1	0	27.8	4	1	1
2018	5/20/2018	34.8	4	1	1			0	0
2018	5/24/2018			0	0	38.9	1	0	0
2018	5/25/2018	41.5	1	0	0	40	2	0	0
2018	5/26/2018	43.6	2	0	0			0	0
2018	5/27/2018	38.6	3	1	0	25	1	0	0
2018	5/28/2018	45.7	4	1	1			0	0
2018	6/8/2018			0	0	25	1	0	0
2018	6/10/2018	40.6	1	0	0	38.5	1	0	0
2018	6/15/2018	48.5	1	0	0	0	1	0	0
2018	6/16/2018	21.7	2	0	0	0	2	0	0
2018	6/17/2018	0	3	1	0	0	3	1	0
2018	6/18/2018	9.5	4	1	1	40	4	1	1
2018	**Total**			**6**	**3**			**4**	**2**
2019	4/28/2019			0	0	0	1	0	0
2019	5/4/2019			0	0	0	1	0	0
2019	5/6/2019			0	0	0	1	0	0
2019	5/10/2019			0	0	46.7	1	0	0
2019	5/11/2019			0	0	46.7	2	0	0
2019	5/16/2019	47.9	1	0	0	25	1	0	0
2019	5/17/2019	35.3	2	0	0	14.3	2	0	0
2019	5/18/2019	24.4	3	1	0	33.3	3	1	0
2019	5/19/2019	34.1	4	1	1			0	0
2019	5/20/2019	45.7	5	1	1			0	0
2019	5/21/2019	48.5	6	1	1	38.5	1	0	0
2019	5/22/2019	35.7	7	1	1	20	2	0	0
2019	5/23/2019	28.1	8	1	1	22.2	3	1	0
2019	5/24/2019	22.2	9	1	1	23.5	4	1	1
2019	5/25/2019	21.6	10	1	1	18.2	5	1	1
2019	5/26/2019	22.9	11	1	1	28.6	6	1	1
2019	5/27/2019	41.9	12	1	1			0	0
2019	5/28/2019	42.4	13	1	1	23.1	1	0	0
2019	5/29/2019	43.2	14	1	1	36.4	2	0	0
2019	5/30/2019	30	15	1	1	31.3	3	1	0
2019	5/31/2019	34.2	16	1	1	36.4	4	1	1
2019	6/1/2019	35.3	17	1	1	42.9	5	1	1
2019	6/3/2019			0	0	25	1	0	0
2019	6/6/2019			0	0	46.7	1	0	0

2019	6/7/2019	48.4	1	0	0	33.3	2	0	0
2019	6/8/2019	44.4	2	0	0			0	0
2019	6/9/2019	41.4	3	1	0	37.5	1	0	0
2019	6/11/2019	45.8	1	0	0	33.3	1	0	0
2019	6/12/2019	44	2	0	0	33.3	2	0	0
2019	6/13/2019	33.3	3	1	0	33.3	3	1	0
2019	6/14/2019	29	4	1	1	14.3	4	1	1
2019	6/15/2019	33.3	5	1	1			0	0
2019	6/16/2019	31.8	6	1	1	28.6	1	0	0
2019	6/17/2019	35	7	1	1	20	2	0	0
2019	6/18/2019	31.3	8	1	1			0	0
2019	**Total**			**22**	**19**			**10**	**6**
2020	4/24/2020			0	0	0	1	0	0
2020	5/6/2020			0	0	33.3	1	0	0
2020	5/10/2020			0	0	38.5	1	0	0
2020	5/11/2020	45.2	1	0	0	40	2	0	0
2020	5/13/2020			0	0	33.3	1	0	0
2020	5/16/2020			0	0	34.8	1	0	0
2020	5/17/2020	42.3	1	0	0	27.8	2	0	0
2020	5/18/2020	28	2	0	0	11.1	3	1	0
2020	5/19/2020	30.6	3	1	0			0	0
2020	5/20/2020	33.3	4	1	1			0	0
2020	5/23/2020			0	0	25	1	0	0
2020	5/24/2020	40	1	0	0	28.6	2	0	0
2020	5/25/2020	18.2	2	0	0	9.1	3	1	0
2020	5/26/2020	13.6	3	1	0	0	4	1	1
2020	5/27/2020	6.7	4	1	1			0	0
2020	5/28/2020	16.7	5	1	1	25	1	0	0
2020	5/29/2020	33.3	6	1	1	36.4	2	0	0
2020	5/30/2020	28.9	7	1	1	20	3	1	0
2020	5/31/2020	36.7	8	1	1			0	0
2020	6/1/2020	42.1	9	1	1			0	0
2020	6/5/2020			0	0	40	1	0	0
2020	6/7/2020	44	1	0	0	16.7	1	0	0
2020	6/13/2020	46.2	1	0	0	10	1	0	0
2020	6/14/2020	46.9	2	0	0			0	0
2020	6/15/2020	32	3	1	0	0	1	0	0
2020	**Total**			**10**	**7**			**4**	**1**
2021	4/7/2021			0	0	0	1	0	0
2021	5/10/2021			0	0	43.8	1	0	0
2021	5/26/2021			0	0	40.9	1	0	0
2021	5/27/2021	45.2	1	0	0	36.4	2	0	0
2021	5/28/2021	44.9	2	0	0			0	0

2021	5/29/2021	41.7	3	1	0	22.2	1	0	0
2021	6/5/2021			0	0	14.3	1	0	0
2021	6/7/2021	48.1	1	0	0			0	0
2021	6/9/2021			0	0	12.5	1	0	0
2021	6/10/2021	41.2	1	0	0	44.4	2	0	0
2021	6/11/2021	43.6	2	0	0			0	0
2021	6/14/2021			0	0	37.5	1	0	0
2021	6/18/2021			0	0	36.4	1	0	0
2021	**Total**			**1**	**0**			**0**	**0**
2022	4/22/2022			0	0	0	1	0	0
2022	4/25/2022			0	0	0	1	0	0
2022	4/28/2022			0	0	0	1	0	0
2022	4/29/2022			0	0	0	2	0	0
2022	5/3/2022	44.4	1	0	0	41.2	1	0	0
2022	5/4/2022	40.5	2	0	0	40	2	0	0
2022	5/12/2022			0	0	45.1	1	0	0
2022	5/13/2022	44	1	0	0	30.6	2	0	0
2022	5/14/2022	40.4	2	0	0	45.5	3	1	0
2022	5/15/2022	39.2	3	1	0			0	0
2022	5/16/2022	41.5	4	1	1	26.7	1	0	0
2022	5/23/2022			0	0	33.3	1	0	0
2022	5/26/2022			0	0	29.2	1	0	0
2022	5/27/2022	47.4	1	0	0	46.4	2	0	0
2022	5/28/2022	39.7	2	0	0	43.8	3	1	0
2022	5/29/2022	48.3	3	1	0			0	0
2022	5/30/2022	49.2	4	1	1	48.6	1	0	0
2022	5/31/2022	41.4	5	1	1	19	2	0	0
2022	6/1/2022	31.1	6	1	1	11.1	3	1	0
2022	6/2/2022	14.3	7	1	1	10	4	1	1
2022	6/3/2022	20.6	8	1	1			0	0
2022	6/4/2022	29.4	9	1	1	0	1	0	0
2022	6/7/2022	44.1	1	0	0	23.1	1	0	0
2022	6/8/2022	37.9	2	0	0	20	2	0	0
2022	6/9/2022	19	3	1	0	9.1	3	1	0
2022	6/10/2022	12.5	4	1	1			0	0
2022	6/11/2022	25.9	5	1	1	37.5	1	0	0
2022	6/12/2022	22.2	6	1	1	10	2	0	0
2022	6/13/2022	17.6	7	1	1	12.5	3	1	0
2022	6/14/2022	12.3	8	1	1	20	4	1	1
2022	6/15/2022	13.2	9	1	1	0	5	1	1
2022	6/16/2022	12.5	10	1	1	0	6	1	1
2022	6/17/2022	0	11	1	1	0	7	1	1
2022	6/18/2022	0	12	1	1	0	8	1	1

2022	**Total**			**19**	**16**			**11**	**6**
2023	4/20/2023			0	0	0	1	0	0
2023	4/22/2023			0	0	0	1	0	0
2023	5/1/2023			0	0	0	1	0	0
2023	5/4/2023			0	0	0	1	0	0
2023	5/6/2023	42.9	1	0	0			0	0
2023	5/18/2023			0	0	44.4	1	0	0
2023	5/19/2023			0	0	45.5	2	0	0
2023	5/20/2023	49.3	1	0	0			0	0
2023	5/21/2023	42.5	2	0	0	16.7	1	0	0
2023	5/22/2023	39.7	3	1	0	39.1	2	0	0
2023	5/23/2023	36.5	4	1	1			0	0
2023	5/24/2023	47.2	5	1	1	47.4	1	0	0
2023	5/25/2023	45.5	6	1	1	36	2	0	0
2023	5/26/2023	47.5	7	1	1			0	0
2023	**Total**			**5**	**4**			**0**	**0**
2024	4/27/2024			0	0	0	1	0	0
2024	5/6/2024			0	0	37.5	1	0	0
2024	5/8/2024	40.5	1	0	0	26.3	1	0	0
2024	5/9/2024	36.4	2	0	0	26.7	2	0	0
2024	5/10/2024	38.6	3	1	0			0	0
2024	5/21/2024			0	0	40	1	0	0
2024	5/24/2024			0	0	33.3	1	0	0
2024	5/25/2024	47.7	1	0	0			0	0
2024	5/30/2024	48.1	1	0	0	33.3	1	0	0
2024	5/31/2024	36.4	2	0	0	21.4	2	0	0
2024	6/1/2024	28	3	1	0			0	0
2024	6/2/2024	30	4	1	1			0	0
2024	6/14/2024			0	0	42.9	1	0	0
2024	6/15/2024	37.8	1	0	0	23.8	2	0	0
2024	6/16/2024	23.4	2	0	0	13.8	3	1	0
2024	6/17/2024	27.1	3	1	0			0	0
2024	6/18/2024	41.9	4	1	1			0	0
2024	**Total**			**5**	**2**			**1**	**0**

Little Goose to Lower Granite

Table 20. Little Goose to Lower Granite "Dot" Dates for Running 3-day Cohort and 1-day Cohort, 2016-2024.

Year	"Dot" Date	Running 3-day Cohort (minimum 7 fish)				1-day Cohort (no minimum)			
		Cumulative Percent	Consecutive Day Count	3 Dots	4 Dots	Cumulative Percent	Consecutive Day Count	3 Dots	4 Dots
2016	4/17/2016			0	0	0	1	0	0
2016	4/25/2016			0	0	0	1	0	0
2016	4/30/2016			0	0	33.3	1	0	0
2016	**Total**			**0**	**0**			**0**	**0**
2017	5/16/2017			0	0	0	1	0	0
2017	6/2/2017	48.1	1	0	0	40.9	1	0	0
2017	6/3/2017	43.3	2	0	0	40.0	2	0	0
2017	6/4/2017	40.7	3	1	0	41.2	3	1	0
2017	6/5/2017	42.2	4	1	1			0	0
2017	6/6/2017	38.6	5	1	1	34.4	1	0	0
2017	6/7/2017	46.2	6	1	1			0	0
2017	**Total**			**4**	**3**			**1**	**0**
2018	5/19/2018			0	0	20	1	0	0
2018	**Total**			**0**	**0**			**0**	**0**
2019	**Total**			**0**	**0**			**0**	**0**
2020	5/12/2020			0	0	0	1	0	0
2020	5/17/2020			0	0	47.1	1	0	0
2020	5/30/2020			0	0	33.3	1	0	0
2020	5/31/2020			0	0	40	2	0	0
2020	6/1/2020	1	0	0	0			0	0
2020	**Total**			**0**	**0**			**0**	**0**
2021	**Total**			**0**	**0**			**0**	**0**
2022	5/30/2022			0	0	36.8	1	0	0
2022	6/11/2022			0	0	40	1	0	0
2022	6/12/2022	36.7	1	0	0	10	2	0	0
2022	6/13/2022	35.7	2	0	0			0	0
2022	6/14/2022	41.2	3	1	0			0	0
2022	**Total**			**1**	**0**			**0**	**0**
2023	5/4/2023			0	0	0	1	0	0
2023	**Total**			**0**	**0**			**0**	**0**
2024	5/10/2024			0	0	0	1	0	0
2024	**Total**			**0**	**0**			**0**	**0**

Appendix 5. DART Tool 2-day Predicted Range New Feature

The "2-day Prediction Range" is a requested new feature for the **DART tool**. In the development version there are 3 settings: off, on, and on with details. By default, it is set to "on" (see Figure 48).

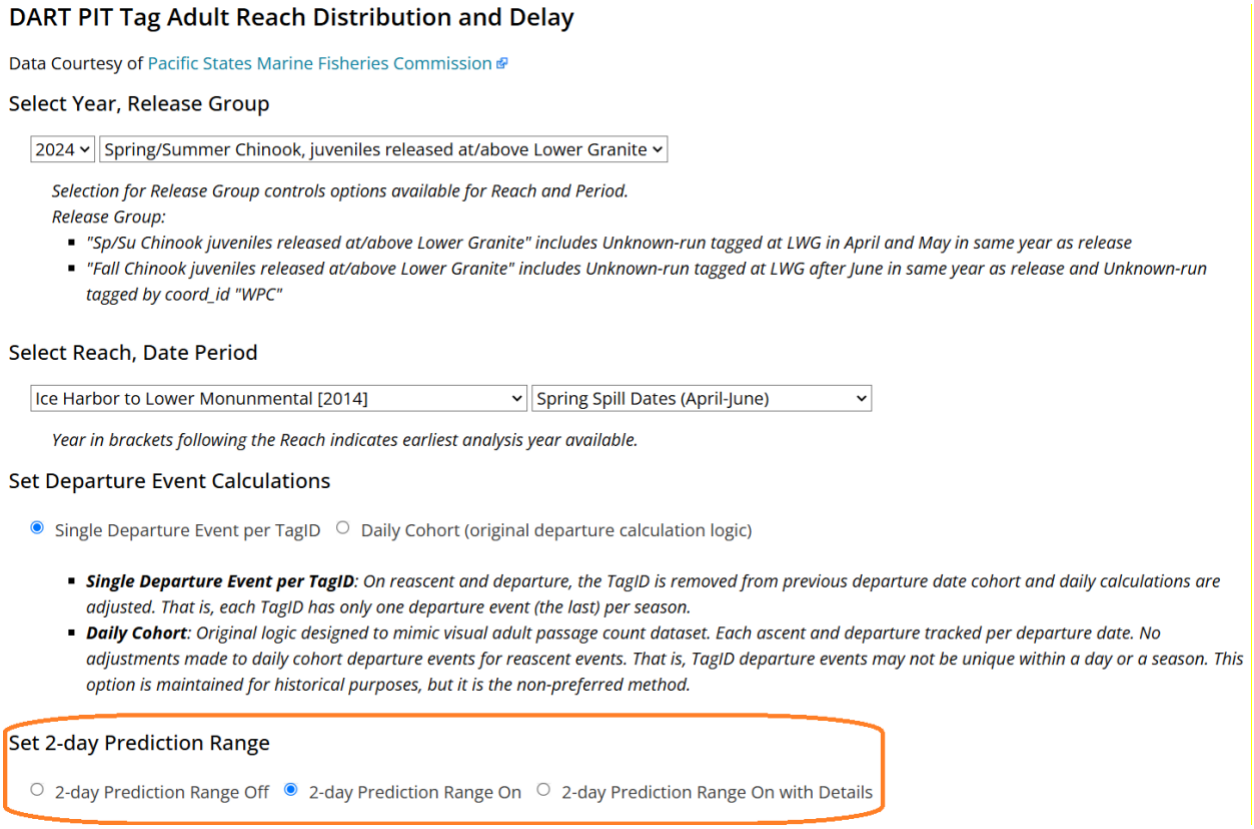


Figure 48. Screen capture of DART Tool with 2-day Prediction Range options.

The "2-day Prediction Range" calculations are applied to the 'Running 3 Day' cohorts and appear in the results table in square brackets and shaded green. The predicted lower limit is based on known arrivals through the maximum data date and the predicted upper limit is based the sum of cumulative arrivals and possible new arrivals (i.e., not arrived). See Section **Error! R eference source not found.** for more details of the prediction range calculations.

Table 21. Example Results including Prediction Range for Running 3 Day Table Single Departure Event per TagID -- Adult PIT Tag, Data Through 06/04.

Running 3 Days End Date (departure events >= 7) ► shaded red: Arrival on Avg (2) Day < 50%	Departure Events Ice Harbor for period	Lower Monumental Entry Events for Fish departing ICH during period viable for Cumulative Arrival % calculations	Cumulative Arrival Percent Lower Monumental Calendar Days after Ice Harbor Departure ► shaded gray: 50% arrival day ► shaded gold: ConRate < 85% (at least 7 fish; fallback, delay, wander, harvest, mortality can all attribute to <100%) ► shaded green: Prediction Range based on departures and detections for individual days included in 3-day cohort								Total Lower Monumental Entry Events for Fish departing ICH during period
			0	1	2	3	4	5	6	Conversion Rate	
2024-06-04	31	0	0.0	[16.1 - 58.1]	[32.3 - 96.8]						10
2024-06-03	24	5	0.0	20.8	[54.2 - 83.3]	[58.3 - 91.7]					14
2024-06-02	28	11	0.0	3.6	39.3	[60.7 - 64.3]	[82.1 - 92.9]				23
2024-06-01	36	18	0.0	11.1	30.6	**50.0**	[66.7 - 72.2]	[75.0 - 86.1]			27
2024-05-31	37	23	0.0	10.8	29.7	45.9	**62.2**	[73.0 - 78.4]	[73.0 - 91.9]		27
2024-05-30	28	20	0.0	14.3	46.4	**53.6**	57.1	71.4	[71.4 - 89.3]		

In Table 22, we take a closer look at 06/03 calculations for the example using last data date 06/04 with explanatory notes for select calculation cells.

Table 22. Example Results including Prediction Range with Explanatory Notes.

Running 3 Days End Date (departure events >= 7) ▻ **shaded red: Arrival on Avg (2) Day < 50%**	**Departure Events Ice Harbor for period**	**Lower Monumental Entry Events for Fish departing ICH during period viable for Cumulative Arrival % calculations**	**Cumulative Arrival Percent Lower Monumental Calendar Days after Ice Harbor Departure** ▻ **shaded gray: 50% arrival day** ▻ **shaded gold: ConRate < 85% (at least 7 fish; fallback, delay, wander, harvest, mortality can all attribute to <100%)** ▻ **shaded green: Prediction Range based on departures and detections for individual days included in 3-day cohort**								**Total Lower Monumental Entry Events for Fish departing ICH during period**
			0	**1**	**2**	**3**	**4**	**5**	**6**	**Con. Rate**	
❶ 2024-06-03	❷ 24	❸ 5	❹ 0.0	❺ 20.8	❻ [54.2 - 83.3]	❼ [58.3 - 91.7]					❽ 14
This date represents the departure cohorts for 2024-06-03 and the prior 2 days: 2024-06-02 and 2024-06-01. That is, all individual PIT-tags departing the lower project on those 3 dates. Departures are cumulated for the 3 dates.	Departures are accumulated for the 3 dates. All PIT-tags are unique and the last known departure for the individual PIT-tag.	For all 3 dates, the number of detections at the upper project that are available for cumulative arrival percent calculations by calendar day. In this example, the only calendar. The last data date (maximum date of data) is 6/4. Calendar days possible for departure date: 6/3: 0,1 6/2: 0, 1, 2 6/1: 0, 1, 2, 3 All three departure dates are required for	Cumulative detections by calendar day 0 for each departure date cohort divided by the cumulative departures divided by departure events ❷.	Cumulative detections by calendar day 1 for each departure date cohort divided by the cumulative departures divided by departure events ❷. This is the maximum possible calendar day accumulation for this 3-day cohort. Therefore, it is ❸ divided by ❷.	Predicted range calculations are possible for this cumulative arrival calendar day (2) because arrivals are possible for calendar day 2 for departure dates 6/2 and 6/1 (see possible calendar days in ❸ descriptive text). **[54.2 - 83.3]** total detected through Cal. Day 2: 13 **lower limit = detected ÷ departures: 13 ÷ 24 = 54.2%**	Predicted range is possible because arrivals are possible for calendar day 3 for departure date 6/1. **[58.3 - 91.7]** total detected through Cal. Day 3: 14❽ **lower limit = detected ÷ departures: 14 ÷ 24 = 58.3%** The upper limit is the accumulated arrivals by Calendar Day 3 plus the possible new arrivals (number of					Total arrivals at the upper project for the 3-day cohort through last data date. There is no restriction on “calendar day” arrival.

		each calendar day calculation. Therefore, with data through 6/4, only calendar day 0 and 1 detections and accumulations are printed in the table.			The upper limit is the accumulated arrivals by Calendar Day 2 plus the possible new arrivals (number of departures for each date in cohort that have not, yet, arrived). 2024-06-01 depart. possible new arrivals: 0 2024-06-02 depart. possible new arrivals: 0 2024-06-03 depart. possible new arrivals: 7 total possible new arrivals : 7 total possible for cal. day = detected + possible new: 13 + 7 = 20 **upper limit = total possible ÷ departures: 20 ÷ 24 = 83.3%**	departures for each date in cohort that have not, yet, arrived). 2024-06-01 depart. possible new arrivals: 0 2024-06-02 depart. possible new arrivals: 1 2024-06-03 depart. possible new arrivals: 7 total possible new arrivals: 8 total possible for cal. day = detected + possible new: 14 + 8 = 22 **upper limit = total possible ÷ departures: 22 ÷ 24 = 91.7%**					