FISH PASSAGE CENTER
1827 NE 44th Ave., Suite 240, Portland, OR 97213
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org/
e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: Paul Wagner (Co-Chair, FPAC)
FPAC

Michele DeHart

FROM: Michele DeHart

DATE: October 18, 2011

RE: Re-ascension rates of adult Chinook at Lower Granite Dam and McNary Dam and spill operations (2007-2011)

In response to your request, the FPC staff has reviewed data on adult PIT-tagged spring/summer and fall Chinook in order to determine if fallback rates for this year (2011) could be developed and compared to historical years (2007-2010) at Lower Granite (LGR) and McNary (MCN) dams. Below is a brief summary of our results, followed by a more detailed explanation.

- Estimating fallback rates with PIT-tags is currently not possible.
- An estimate of re-ascension rates can be made based on adult fish that were detected exiting the adult ladder and were detected again as they re-ascended into the adult ladder. The relationship between re-ascension rates and fallback rates is not understood from PIT-tag analyses.
- During the fish spill season, the spill volumes in 2011, a high flow year, at LGR and MCN dams were the highest among the five years we analyzed. Average daily spill volume at LGR was 40.7 Kcfs and average daily spill volume at MCN was 193.1 Kcfs.
- The daily average spill proportion at LGR in 2011 (0.39) was the fourth highest among the years we analyzed. At MCN, the daily average spill proportion (0.56) was the highest among the years analyzed.
- The high spill volumes and spill proportions at LGR and MCN in 2011 were largely due to the high flows, but also due to unit outages at both projects that resulted in reduced powerhouse capacity during much of the voluntary spill season.

- The overall LGR proportion re-ascension in 2011 (through October 2, 2011) was 0.083, which is the second highest overall proportion re-ascension among the years analyzed. With an overall proportion re-ascension of 0.093, return year 2008 was the highest among the years analyzed.
- In general, logistic regression analyses revealed a significant effect of spill volume and spill proportion on the probability of re-ascension at LGR. However, goodness of fit analyses revealed a general lack of fit in these models. Therefore, caution should be used when trying to use the logistic models to predict the probability of re-ascension.
- All logistic regression models for LGR seem to suggest that only when flows are above powerhouse capacity there appears a probability of re-ascension that is greater than 0.10. In fact, the models seem to suggest that spill at LGR could be increased to gas cap (41 Kcfs) without a significant impact on re-ascension rates.
- The overall MCN proportion re-ascension in 2011 (through October 2, 2011) was 0.029, which was only slightly higher than past years.
- As at Lower Granite Dam, logistic regression analyses revealed a significant effect of spill volume and spill proportion on the probability of re-ascension at MCN. However, goodness of fit analyses revealed a general lack of fit for many of these models. Therefore, caution should be used when trying to use the logistic models to predict the probability of re-ascension.
- All logistic regression models for MCN seem to suggest that even when spill volumes or spill proportions were high, the predicted probability of re-ascension was fairly low (generally < 0.05). In fact, at no point did the predicted probability of re-ascension exceed 0.10 (under the conditions observed in each year).

Methods:

Estimating Re-ascension Rates:

Both Lower Granite and McNary dams have PIT-tag detection capability in their adult ladders. To assess re-ascension rates at these two projects, we relied on PIT-tag detections of adult spring/summer and fall Chinook in their respective ladders. Only fish that originated above the specific project were included in these analyses, as fish originating below the project that fell back would not necessarily be expected to re-ascend the ladder. For this analysis, we evaluated adult PIT-tag detections by coil from PTAGIS data for hatchery and wild spring/summer and fall Chinook detections for the years 2007 to 2011. Adult detections for 2011 are through October 2^{nd} for both LGR and MCN.

Our analysis looked at the proportion of adult PIT-tagged fish (including jacks) that were detected re-ascending the adult ladder at each of the projects (LGR & MCN). Fish were considered to have exited the ladder up-river if a detection at an uppermost coil was their last detection. Fish were considered to re-ascend if, once they successfully exited, they were again detected at a lowermost downstream coil at least 3 hours later. Typically the gap between upstream exit and downstream re-detection was in the order of 24 hours (or longer), however, a few fish were found to have re-ascended relatively quickly (4 to 5 hours) so that a shorter “time-gap” was necessary. In addition, many fish ascended and descended within the ladder. A fish that was detected moving down the ladder was not considered to have re-ascended the ladder since it first had to successfully exit the ladder. Finally, some adults are removed at the adult ladder at LGR for hatchery broodstock. We excluded these fish from the analysis at LGR. Including adults that were not detected above the adult trap would inflate the number of total number of adult detections and, thus, potentially bias the re-ascension rate low. Re-ascension rate estimates are based on PIT-tagged individuals that were detected re-ascending the adult ladder, regardless of how many times each individual re-ascended. In other words, if an individual fell back and re-ascended multiple times, that individual would only be considered a single re-ascension.

Logistic Regression of Re-ascension and Spill Operations:

To assess whether spill operations at LGR and MCN have an effect on re-ascension, we performed logistic regression analyses. Each individual PIT-tagged fish that was detected in the adult ladder at LGR or MCN was given a code based on whether that individual was a confirmed re-ascension. If a PIT-tagged individual was determined to re-ascend, it was given a code of "1", whereas a PIT-tagged individual that did not re-ascend the adult ladder was given a code of "0". Each individual was then assigned an average spill volume (Kcfs) and daily spill proportion for the date that individual was first detected at the project. Separate logistic regression analyses were done for the two spill variables: daily spill volume and daily spill proportion. We were not able to assess the impact that other project operations (i.e., number and/or location of individual spillbays and turbine units in operation) might have had on the probability of operation.

To assess model fit for each of the models (i.e., spill and spill proportion), we used the le Cessie-van Houwelingen-Copas-Hosmer unweighted sum of squares test for global goodness of fit (Hosmer et al. 1997). With this test, a significant result (i.e., $\alpha < 0.05$) indicates a general lack of fit. To illustrate the prediction made by the models, we estimated the probability of re-ascension, based on the parameter estimates provided by the logistic regression analyses. To estimate the predicted probability of re-ascension (P), we used the equation:

$$P = \frac{1}{1 + e^{-(\beta_0 + \beta_1 * x)}} \qquad (1)$$

where P is the predicted probability of re-ascension, β_0 is the model intercept, β_1 is the coefficient for spill or spill proportion and x is the value of spill volume or spill proportion (Klienbaum and Klien 2010). The prediction curves were only extrapolated for the range of spill volumes and spill proportions that were seen in each year at each site. To illustrate how the goodness of fit for the logistic models to the observed data, we binned the observed data based on spill volume and spill proportion and estimated the proportion re-ascending in each bin. These estimates of proportion re-ascending were then plotted next to the predicted probability of re-ascension for each model in the analysis.

Lower Granite Dam Results:

During the 2011 spill season, there was concern that the high spill volumes at Lower Granite Dam (LGR) might have resulted in increased fallback rates of adult Chinook at that project. From April 3 to August 31st, spill at LGR in 2011 ranged from 18.42 Kcfs to 111.35 Kcfs. The seasonal average spill of 40.68 Kcfs was the highest seasonal average spill observed over the past 5 years during the fish spill period of April 3rd to August 31st (Table 1). The high spill at LGR in 2011 was due not only to the high flows in the Snake River but also unit outages and transmission repairs that occurred throughout the voluntary spill season. While the seasonal average spill volume in 2011 was the highest over the past five years, the seasonal spill proportion of 0.39 was not the highest, as 2007, 2008, and 2010 all had higher seasonal average spill proportions than 2011 during the fish spill period of April 3rd to August 31st (Table 1).

Table 1. Seasonal average spill volume (Kcfs) and spill proportion at Lower Granite Dam in 2007-2011 (April 3-August 31).

Year	Average Spill (Kcfs)	Average Spill Proportion
2007	17.58	0.43
2008	32.97	0.41
2009	24.44	0.35
2010	24.12	0.41
2011	40.68	0.39

The results of our analysis found that the overall proportion re-ascension of PIT-tagged adult Chinook at LGR ranged from 0.033 in 2010 to 0.093 in 2008 (Table 2). At 0.083, the overall proportion re-ascension for 2011 (through October 2nd) is the second highest among the five years analyzed, with only 2008 having a higher overall proportion re-ascension (0.093) (Table 2).

Table 2. Overall proportion re-ascension for PIT-tagged adult Chinook at Lower Granite Dam (2007-2011). **2011 adult returns are through October 2, 2011**

Return Year	PIT-tag Adult Count	Number of Re-ascending Adult	Proportion Re-ascending
2007	1,342	50	0.037
2008	3,241	301	0.093
2009	6,256	362	0.058
2010	7,391	246	0.033
2011†	5,766	477	0.083

† 2011 detection data were through October 2nd and may not capture all re-ascending fish since all detection information may not be complete.

Figures 1 through 5 provide an illustration of the variability in daily re-ascension rates at LGR for the years in this analysis, along with variation in the daily average spill volumes (Kcfs) throughout the season. Due to large differences in the number of PIT-tagged adults returning to LGR between the five return years analyzed, y-axis for adult PIT-tag and re-ascension detections in some of these figures are different and, thus, between-year comparisons should be done with caution. We have standardized the x-axis and y-axis for spill volume between the return years.

As is illustrated in these figures, re-ascension occurs both during the voluntary spill season (Apr 3-Aug 31) and outside the voluntary spill season. Furthermore, during the voluntary spill season, re-ascension occurred both when flows were manageable (i.e., spill met or was below the prescribed operation) and when flows were not manageable (i.e., spill exceeded prescribed operations).

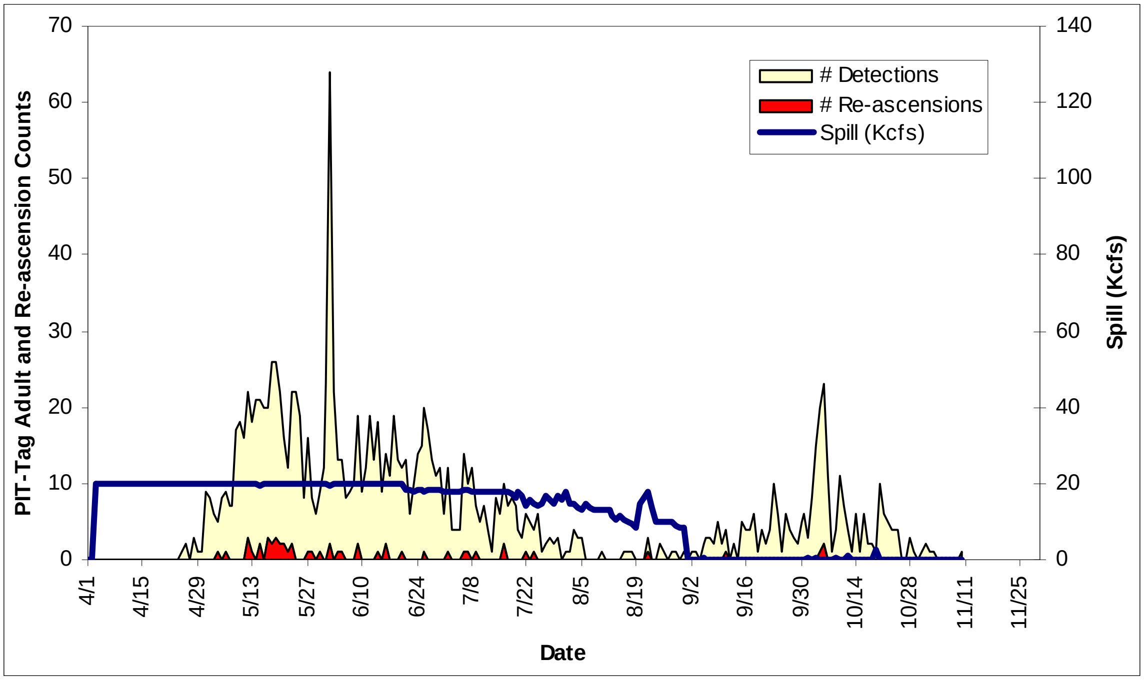

Figure 1. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at LGR in 2007.

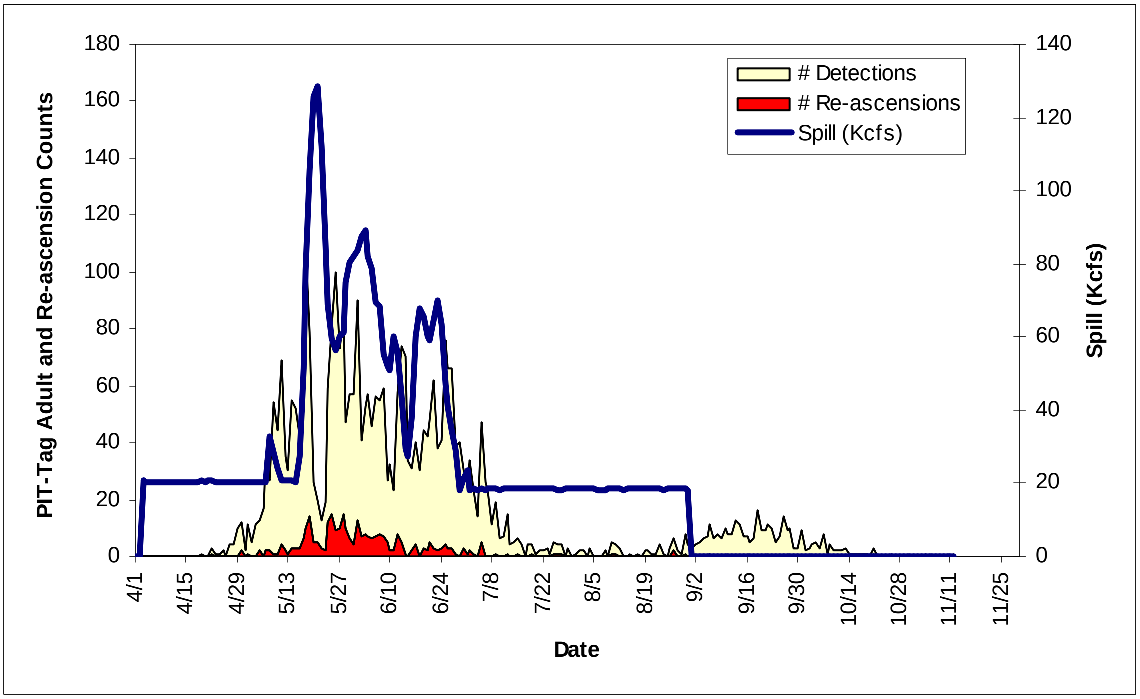

Figure 2. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at LGR in 2008.

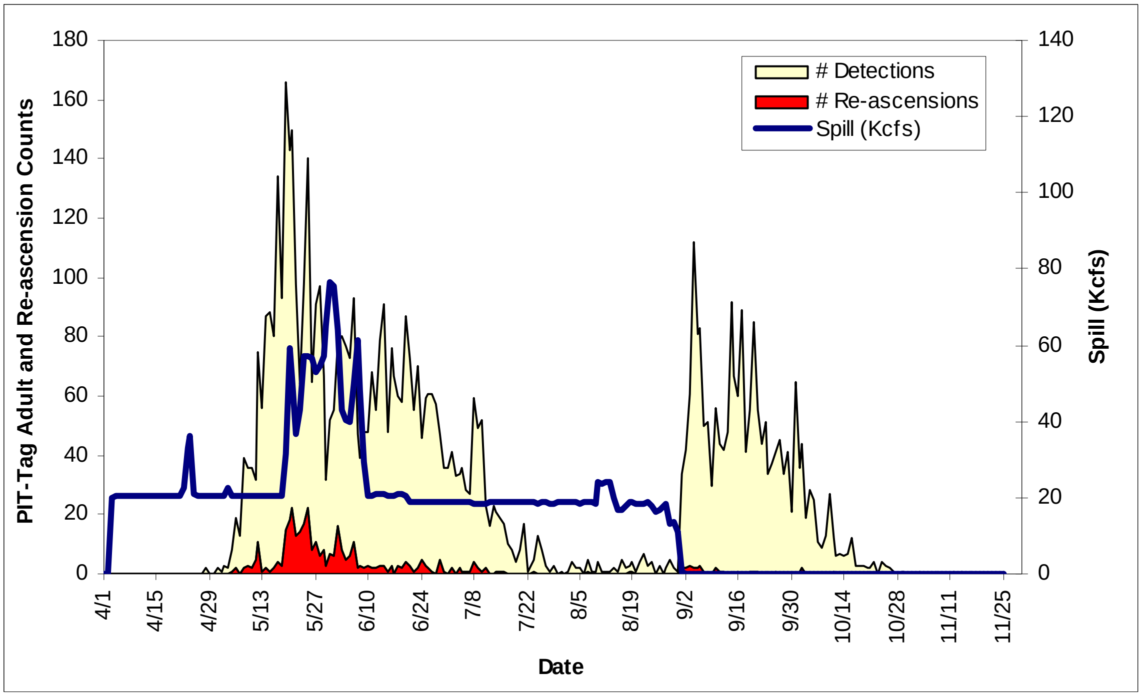

Figure 3. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at LGR in 2009. For the period of January 1 to April 1, 2009, one PIT-tagged Chinook adult was detected at LGR. This adult was not determined to re-ascend and there was 0 Kcfs spill on the date (Mar. 9) it was detected.

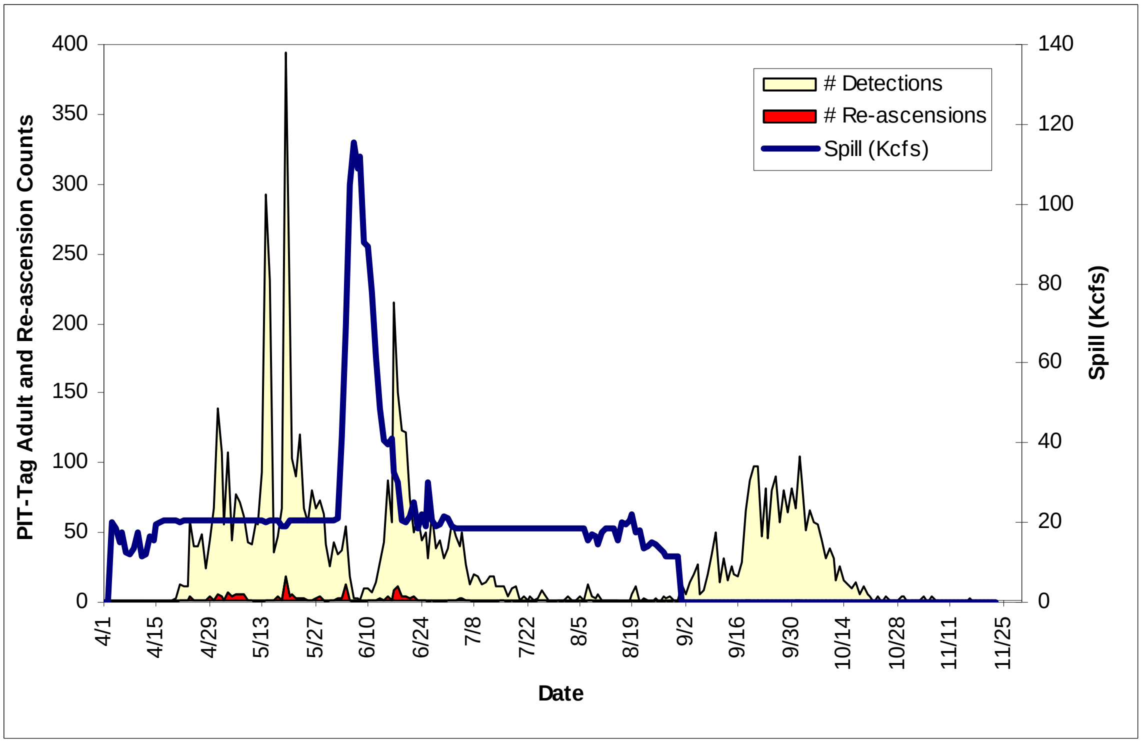

Figure 4. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at LGR in 2010. For the period of January 1 to April 1, 2010, one PIT-tagged Chinook adult was detected at LGR. This adult was not determined to re-ascend and there was 0 Kcfs spill on the date (Mar. 22) it was detected.

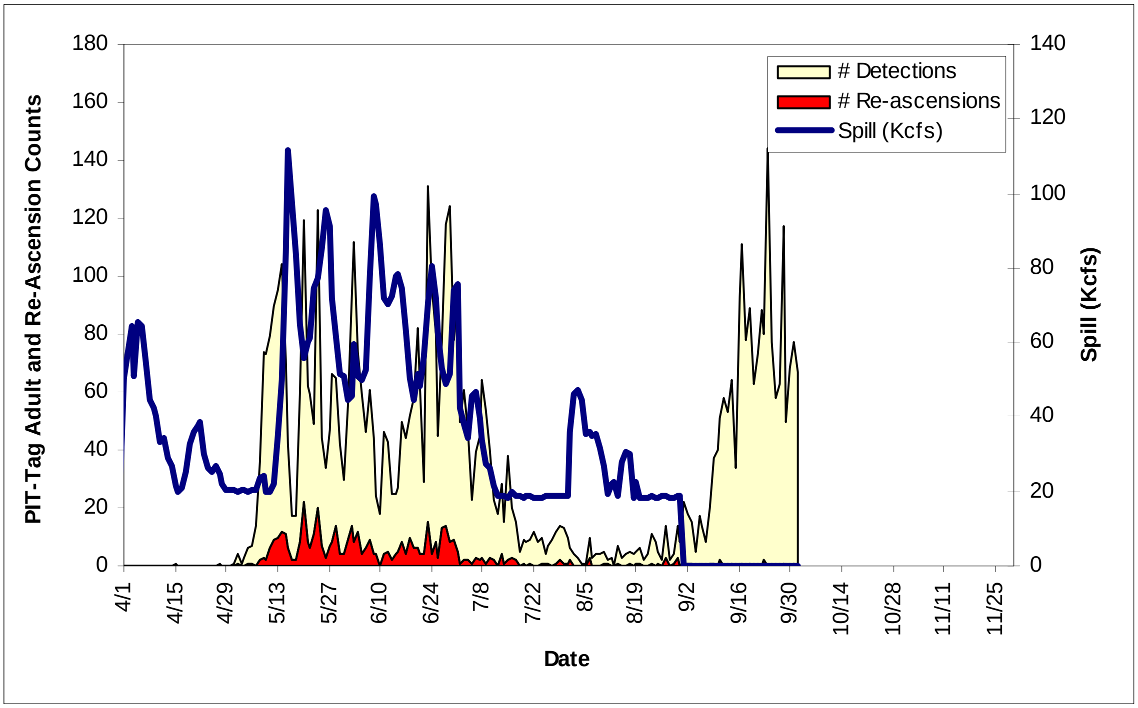

Figure 5. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at LGR in 2011. For the period of January 1 to April 1, 2011, one PIT-tagged Chinook adult was detected at LGR. This adult was not determined to re-ascend and there was 0 Kcfs spill on the date (Mar. 29) it was detected. Analysis of return year 2011 is limited to adults detected at LGR through October 2nd.

Logistic regression analyses revealed that, in almost every year, both spill and spill proportion had a significant effect on the probability of re-ascension at LGR (Table 4). The only exception to this was in 2007, where spill proportion was not significant (p=0.5863) (Table 4). In general, as spill or spill proportion increases, the probability of re-ascension increases. However, goodness-of-fit tests revealed that there was a general lack of fit for both models for return years 2009, 2010, and 2011 (i.e., $p < 0.05$) (Table 4). This indicates that, although spill and spill proportion appeared to have a significant effect on probability of re-ascension, these models generally did not fit the observed data very well.

Table 4. Logistic regression analysis and goodness of fit test results for PIT-tagged Chinook adult re-ascension at LGR (2007-2011).

Return Year	Model	Intercept (β_0)	Coefficient (β_1)	Likelihood Ratio Test (p-value)	Unweighted Sum-of-Squares Test of Model Fit (p-value)
2007	Spill	-4.2161	0.058	0.014	0.656
	Prop. Spill	-3.3831	0.4277	0.5863	0.176
2008	Spill	-3.4229	0.022	<0.0001	0.054
	Prop. Spill	-4.3548	5.0301	<0.0001	0.632
2009	Spill	-3.8857	0.038	<0.0001	**0.000**
	Prop. Spill	-3.9647	5.0241	<0.0001	**0.000**
2010	Spill	-4.0299	0.0331	<0.0001	**0.000**
	Prop. Spill	-4.52	4.4087	<0.0001	**0.024**
2011	Spill	-3.4322	0.023	<0.0001	**0.000**
	Prop. Spill	-3.6805	4.3818	<0.0001	**0.000**

Logistic regression analyses of return year 2007 revealed a significant effect of spill volume on probability of re-ascension but no significant effect of spill proportion (Table 4). Furthermore, goodness of fit tests revealed that both models had good fit (i.e., $p > 0.05$) (Table 4, Figure 6). Despite the significant effect of spill volume on probability of re-ascension, the logistic regression model for spill volume predicted a maximum probability of re-ascension of 0.045 at a spill volume of 20 Kcfs, which was the maximum spill observed in 2007. This indicates that under controlled spill conditions, probability of re-ascension is generally low. With the low flows in 2007, there were times that 20 Kcfs spill equated spill proportions as high as 0.60. According to the logistic regression model for 2007, spill proportions of 0.60 would result in a probability of re-ascension of 0.042.

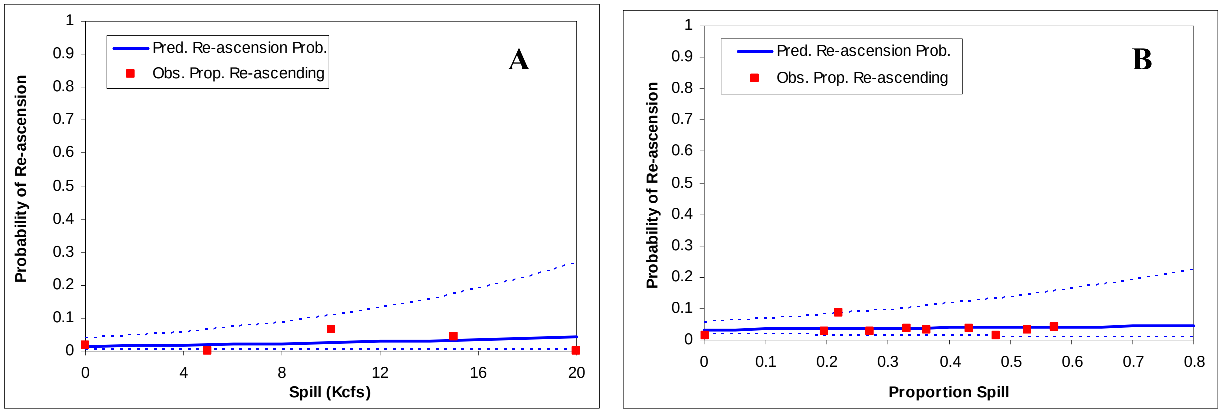

Figure 6. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at LGR in 2007, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

Logistic regression analyses of return year 2008 revealed a significant effect of spill volume and spill proportion on probability of re-ascension (Table 4). In general, as spill volume or spill proportion increased the probability of re-ascension also increased (Figure 7). Furthermore, goodness of fit tests revealed that both models had good fit (i.e., $p > 0.05$) (Table 4, Figure 7). As with the results for return year 2007, the 2008 logistic regression analyses indicate that the probability of re-ascension is relatively low when spill levels are at manageable levels. In fact, only when spill $\geq$ 60 Kcfs does the probability of re-ascension go above 0.10. Spill of 60 Kcfs at LGR would only occur when flows are at uncontrollable levels. This same pattern is true when considering spill proportion. Only when spill proportions are $\geq$0.45 does the model predict a probability of re-ascension above 0.10.

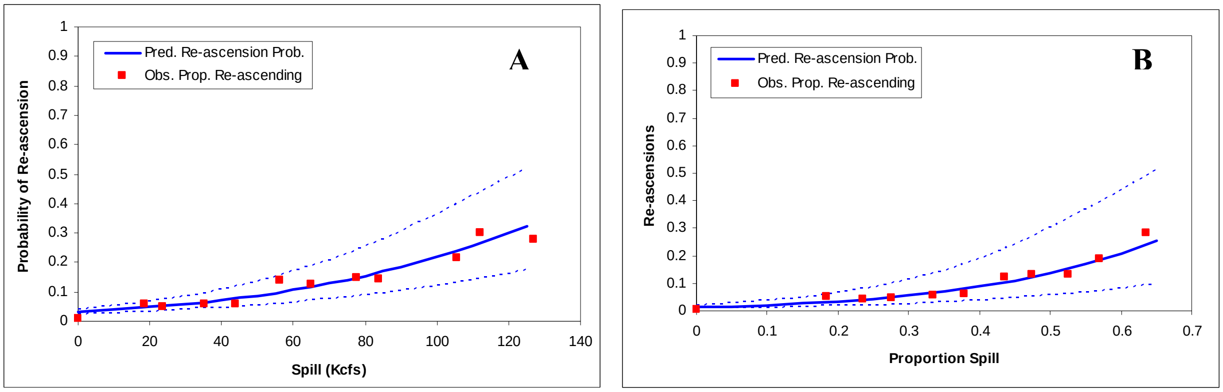

Figure 7. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at LGR in 2008, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

Logistic regression analyses of return year 2009, 2010, and 2011 revealed a significant effect of spill volume and spill proportion on probability of re-ascension for in all three years (Table 4). In general, as spill volume or spill proportion increased the probability of re-ascension also increased (Figures 8-10). However, goodness of fit tests revealed that both models for these return years had a lack of fit (i.e., $p < 0.05$) (Table 4, Figures 8-10). The lack of fit seems to occur mostly at the higher ends of spill volumes and spill proportions. This is likely due to low sample sizes at these spill volumes, as well as issues with using PIT-tags to estimate re-ascension rates.

As with the results for return years 2007 and 2008, the 2009-2011 logistic regression analyses indicate that the probability of re-ascension is relatively low when flows are at manageable levels. In fact, in 2009, only when spill was ≥ 45 Kcfs did the predicted probability of re-ascension go above 0.10 (Figure 8). The spill volume that resulted in a predicted probability of 0.10 was 60 Kcfs for 2010 (Figure 9) and 55 Kcfs for 2011 (Figure 10). Under current management, spill of > 45 Kcfs at LGR would only occur when flows are at uncontrollable levels. Furthermore, 45 Kcfs is above the estimated gas cap at LGR, which is approximately 41 Kcfs.

This same pattern is true when considering spill proportion. In 2009, the estimated probability of re-ascension only exceeded 0.10 when the spill proportion was ≥0.40 (Figure 8). For 2010, the estimated probability of re-ascension exceeded 0.10 when spill proportions were in excess of 0.5 (Figure 9). Finally, for 2011, the probability of re-ascension exceeded 0.10 when the spill proportions were in excess of 0.35 (Figure 10).

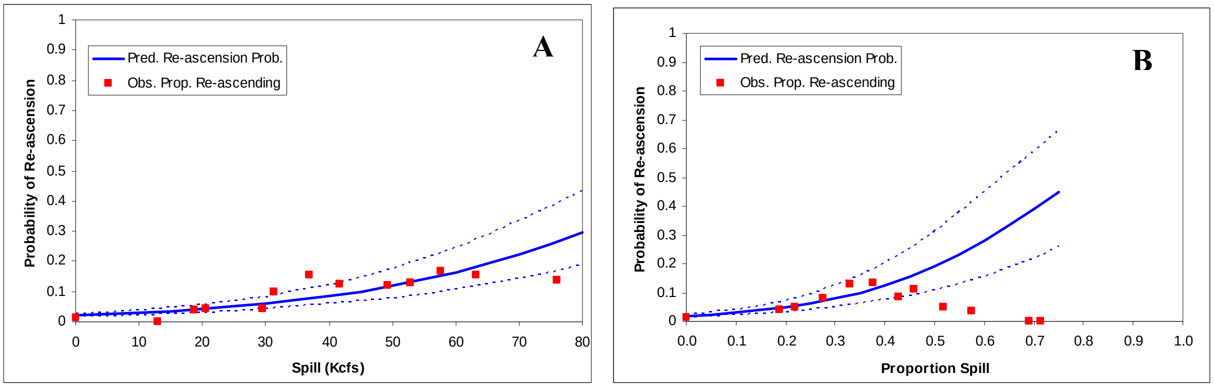

Figure 8. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at LGR in 2009, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

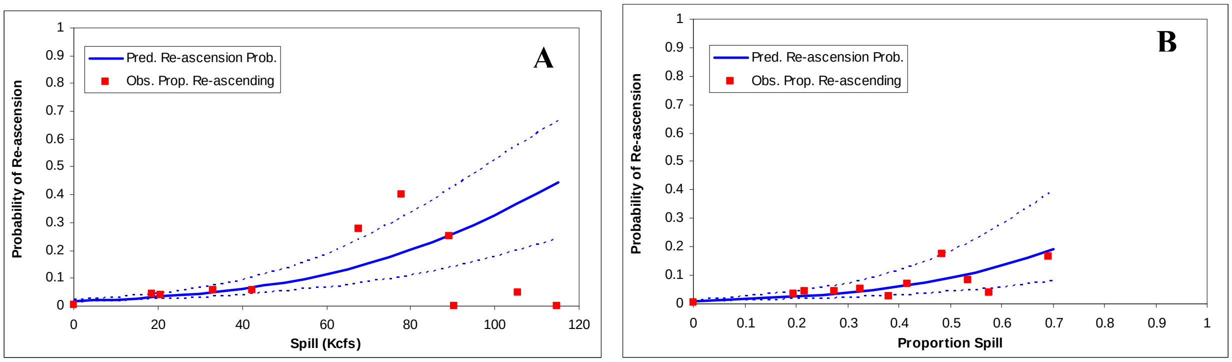

Figure 9. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at LGR in 2010, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

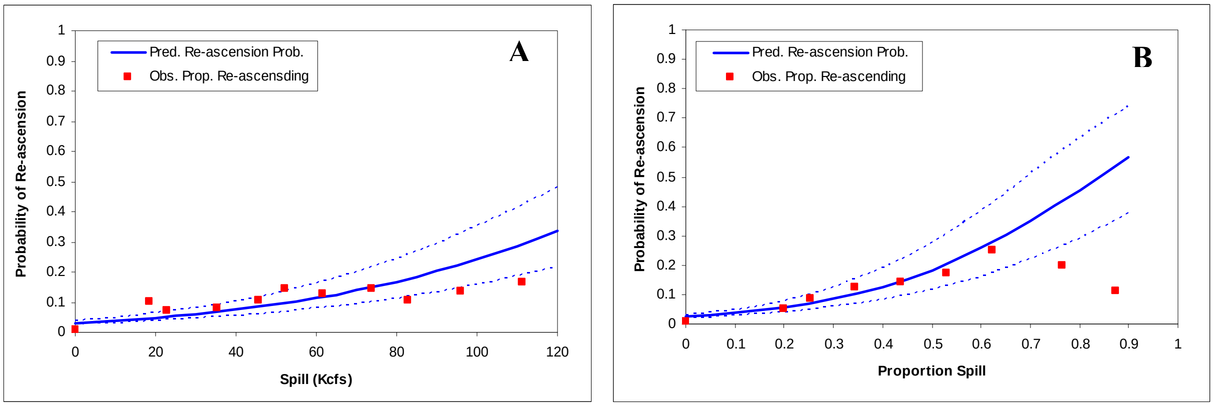

Figure 10. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at LGR in 2011, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

It is important to note that the general lack of fit for these models warrants caution when using them to make predictions of the probability of re-ascension under particular spill operations. Furthermore, the data seem to indicate that re-ascension rates may decrease when spill volumes or spill proportions get really high (Figures 8-10). This could be a function of low sample sizes at these high spill volumes or high spill proportions. However, it could also be that re-ascension is difficult at these high levels of spill and, thus, fish are not re-ascending. Using PIT-tags, there is no way to determine whether this is a limitation of the data, or if it's something biologically significant.

McNary Dam Results:

As with spill at LGR in 2011, there was concern that the high spill volumes at McNary (MCN) in 2011 may also have resulted in increased fallback rates of adult Chinook. During the voluntary spill season (April 10th to August 31st), spill at MCN in 2011 ranged from 82.7 Kcfs to 356.0 Kcfs. The seasonal average spill of 193.1 Kcfs was the highest seasonal average spill observed over the past 5 years during the voluntary spill period of April 10th to August 31st (Table 5). The seasonal average spill proportion at MCN in 2011 was 0.56, which is also the highest observed over the past 5 years (Table 5). As with LGR, the high spill volumes and spill proportions at MCN in 2011 was due not only to the high flows Columbia River but also to unit outages that occurred throughout the voluntary spill season. These unit outages decreased the powerhouse capacity at the project and, therefore, excess spill was necessary through much of the spill season.

Table 5. Seasonal average spill volume (Kcfs) and spill proportion at McNary Dam in 2007-2011 (April 10-August 31).

Year	Average Spill (Kcfs)	Average Spill Proportion
2007	91.1	0.45
2008	118.0	0.48
2009	97.5	0.46
2010	90.8	0.46
2011	193.1	0.56

The results of our analysis found that the overall proportion re-ascension of PIT-tagged adult Chinook at LGR ranged from 0.02 in 2008 and 2010 to 0.029 in 2011 (Table 6). At 0.029, the overall proportion re-ascension for 2011 (through October 2nd) is the highest among the five years analyzed. However, at 0.029, the 2011 overall proportion re-ascension is well within the range of the other four years in the analysis (Table 6).

Table 6. Overall re-ascension Rates for PIT-tagged adult Chinook at McNary Dam (2007-2011). **2011 adult returns are through October 2, 2011**

Return Year	PIT-tag Adult Count	Number of Re-ascending Adult	Percent Re-ascending
2007	3,310	80	2.4%
2008	5,051	102	2.0%
2009	9,657	212	2.2%
2010	10,793	216	2.0%
2011†	9,579	281	2.9%

† 2011 detection data were through October 2nd and may not capture all re-ascending fish since all detection information may not be complete.

Figures 11 through 15 provide an illustration of the variability in daily re-ascension rates at MCN for the years in this analysis, along with variation in the daily average spill volumes (Kcfs) throughout the season. As with the figures for LGR, there was a large degree of variability in the adult PIT-tag detections between the five return years. Given this, the y-axis for PIT-tagged adult and re-ascension detections in many of these figures are different and, thus, between-year comparisons should be done with caution. We have standardized the x-axis and y-axis for spill volume between the return years.

As is illustrated in these figures, re-ascension occurs both during the fish spill season (Apr 10-Aug 31) and outside the fish spill season. Furthermore, during the fish spill season, re-ascension occurred both when flows were manageable (e.g., 2007 and 2010) and when flows were not manageable (e.g., 2008, 2009, and 2011).

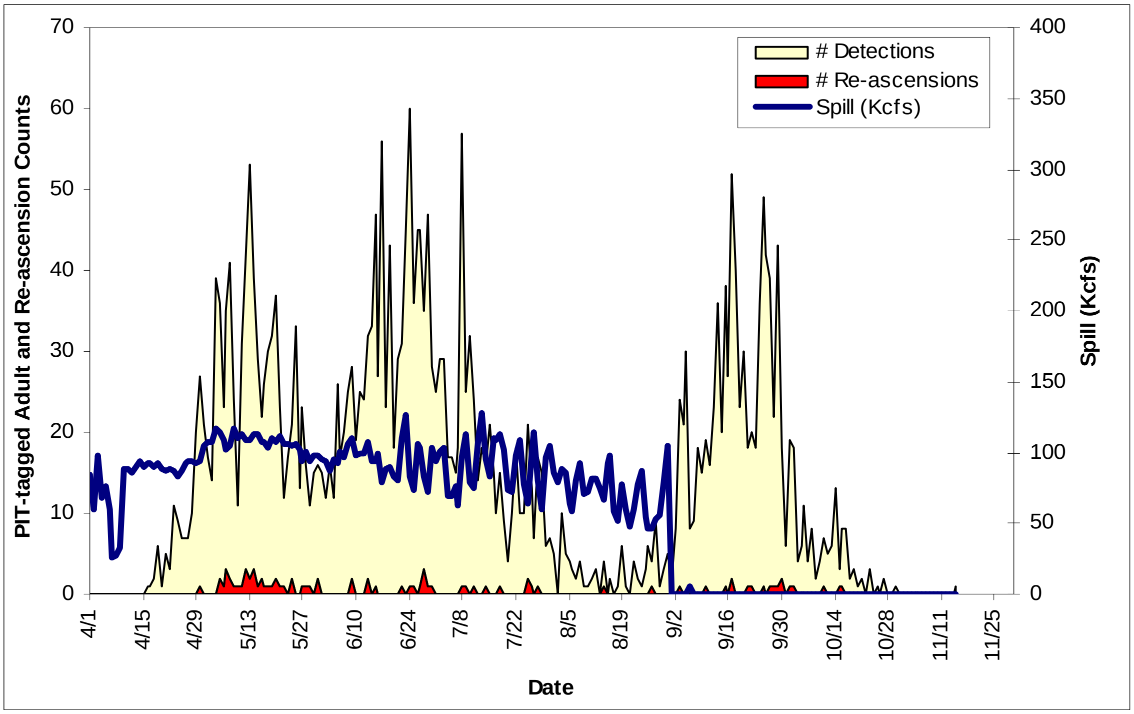

Figure 11. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at MCN in 2007. For the period of January 1 to April 1, 2007 a total of four PIT-tagged Chinook adults were detected at MCN. None of these adults were determined to re-ascend and there was 0 Kcfs spill on the dates when they were detected.

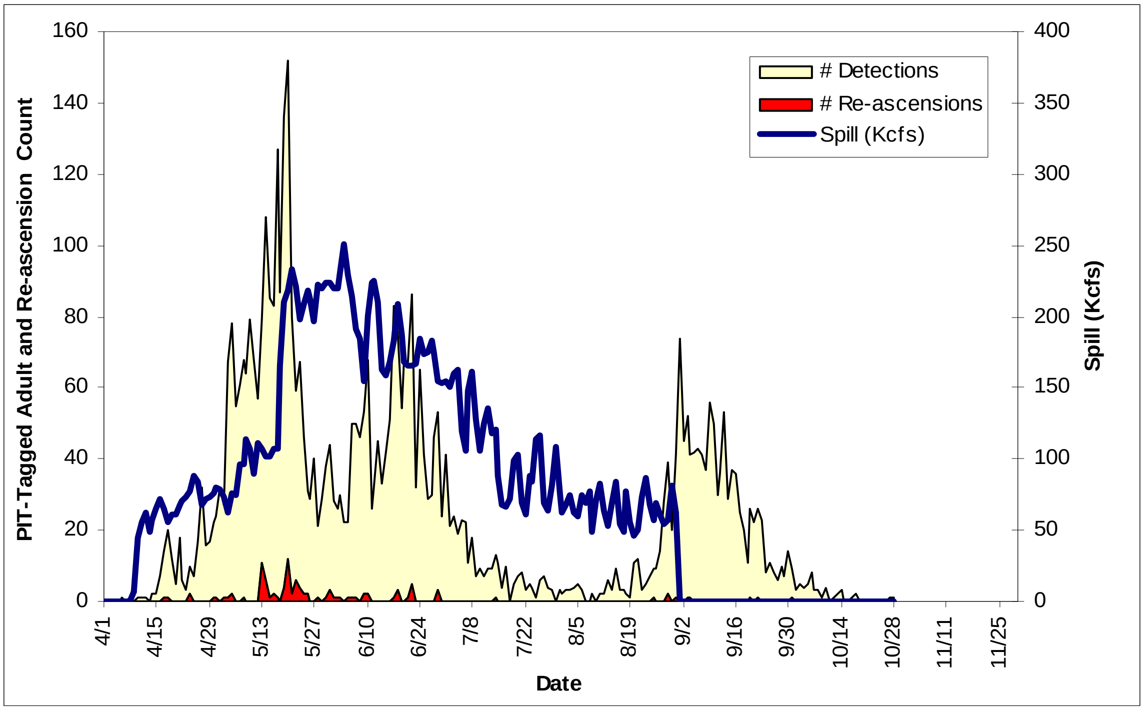

Figure 12. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at MCN in 2008. For the period of January 1 to April 1, 2008 one PIT-tagged Chinook adult was detected at MCN. This adult was not determined to re-ascend and there was 0 Kcfs spill on the day (Mar 7) when this adult was detected.

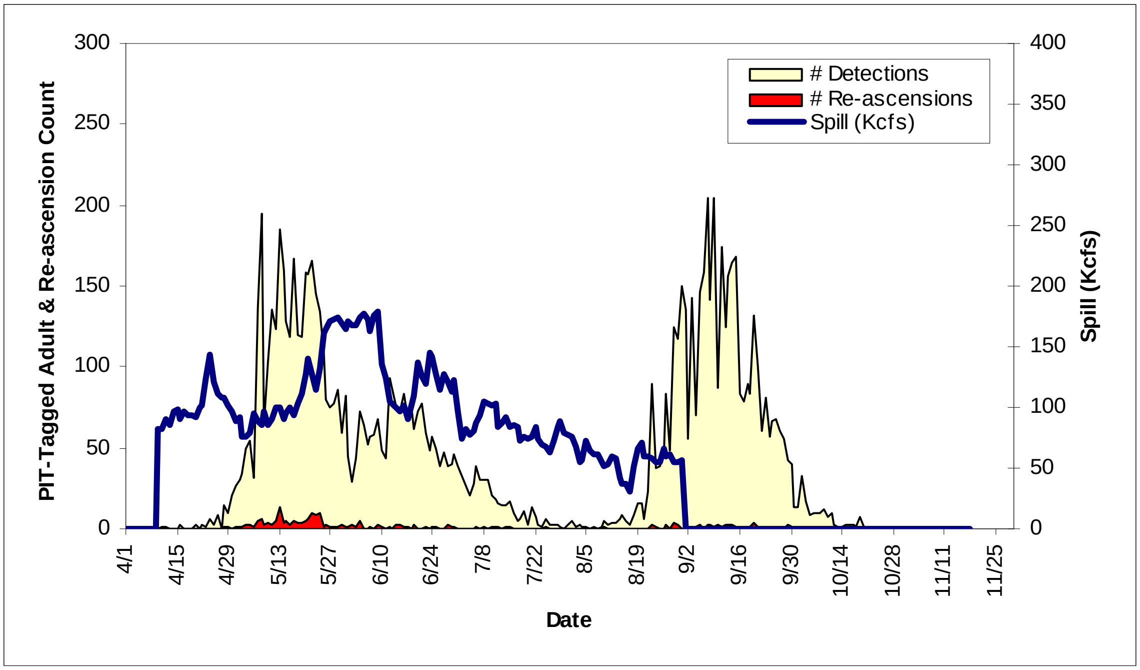

Figure 13. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at LGR in 2009. For the period of January 1 to April 1, 2009 a total of seven PIT-tagged Chinook adults were detected at MCN. None of these adults were determined to re-ascend and there was 0 Kcfs spill on the dates when they were detected.

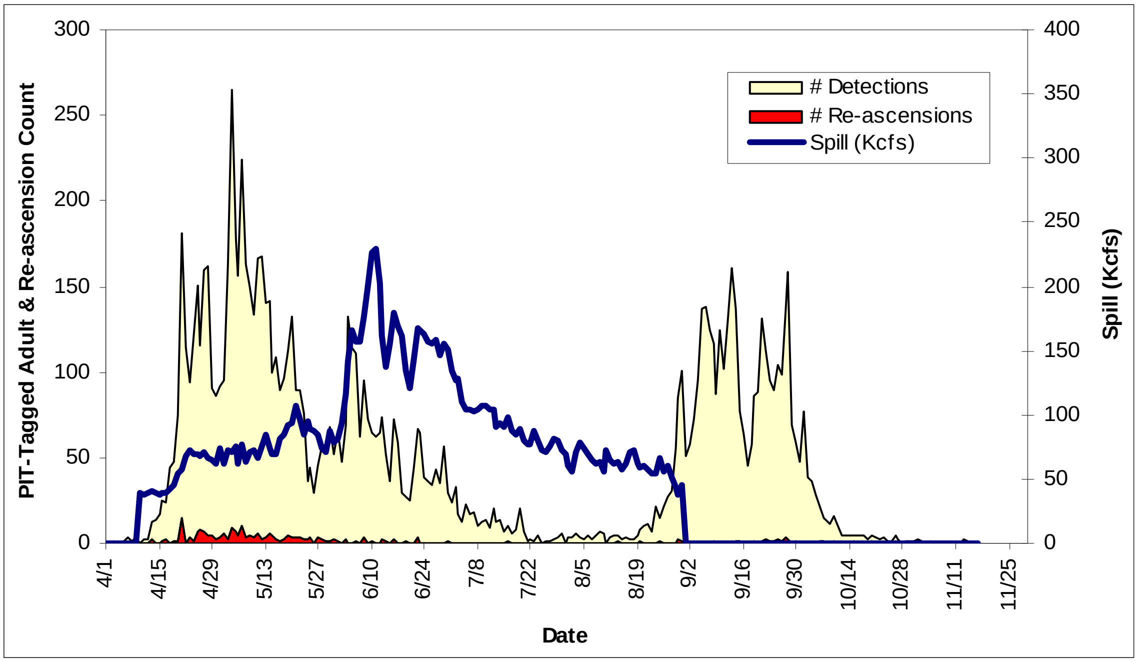

Figure 14. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at LGR in 2010. For the period of January 1 to April 1, 2010 a total of six PIT-tagged Chinook adults were detected at MCN. None of these adults were determined to re-ascend and there was 0 Kcfs spill on the dates when they were detected.

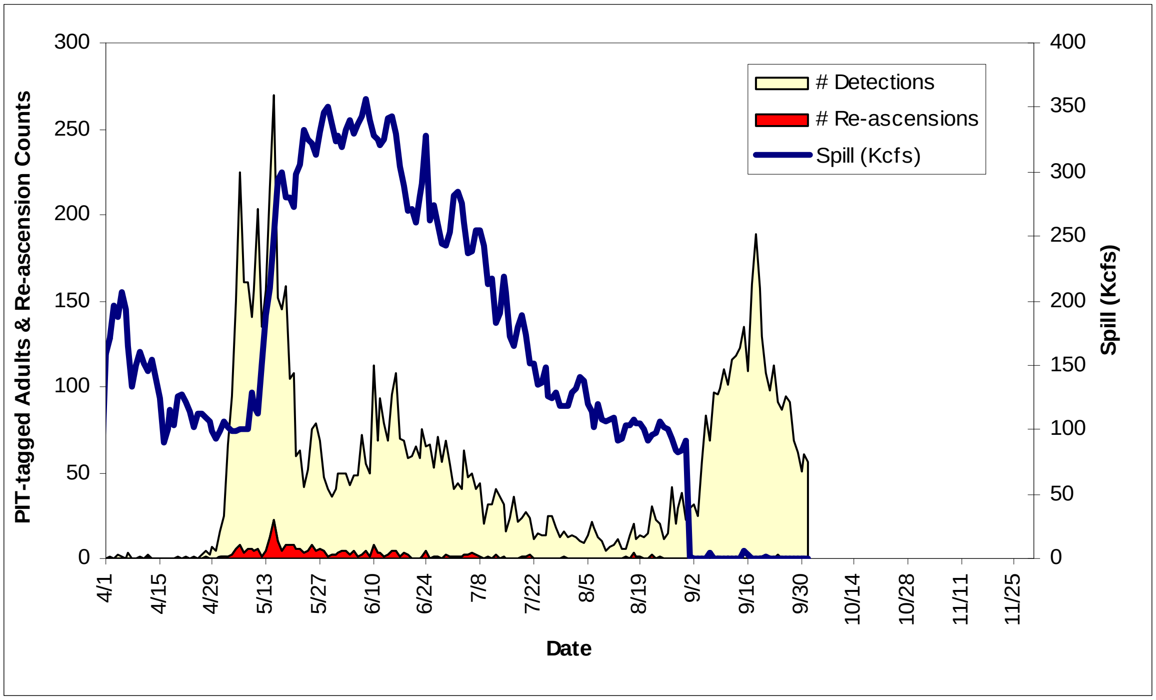

Figure 15. Adult Chinook PIT-tag and re-ascension detections and daily average spill volume at LGR in 2011. For the period of January 1 to April 1, 2011 a total of four PIT-tagged Chinook adults were detected at MCN. None of these adults were determined to re-ascend. However, there was spill on the days that these adults were detected, which ranged from 16 to 60 Kcfs. Analysis of return year 2011 is limited to adults detected at LGR through October 2^{nd}.

Logistic regression analyses revealed that, in almost every year, both spill and spill proportion had a significant effect on the probability of re-ascension at LGR (Table 7). The only exceptions to this were in 2007 when neither spill variable had a significant effect (spill volume $p = 0.172$, spill proportion $p = 0.8119$) and in 2010 when spill volume was not significant ($p=0.1002$) (Table 7). For those years where the spill variable(s) had a significant effect on the probability of re-ascension, as spill or spill proportion increased, the probability of re-ascension also increased. However, goodness-of-fit tests revealed that there was a general lack of fit for both models for return years 2009 and 2010, as well as a lack of fit for the spill proportion model in 2007 and the spill volume model in 2011 (i.e., $p < 0.05$) (Table 7). This indicates that, although spill and spill proportion appeared to have a significant effect on probability of re-ascension, these models generally did not fit the observed data very well.

Table 7. Logistic regression analysis and goodness of fit test results for adult re-ascension at MCN (2007-2011).

Return Year	Model	Intercept (β_0)	Coefficient (β_1)	Likelihood Ratio Test (p-value)	Unweighted Sum-of-Squares Test of Model Fit (p-value)
2007	Spill	-3.9647	0.0036	0.172	0.176
	Prop. Spill	-3.7409	0.1311	0.8119	**0.021**
2008	Spill	-4.7734	0.007	<0.0001	0.856
	Prop. Spill	-5.1381	2.8889	<0.001	0.805
2009	Spill	-4.2709	0.006	<0.0001	**0.000**
	Prop. Spill	-4.3528	1.6986	<0.0001	**0.000**
2010	Spill	-4.0241	0.002	0.1002	**0.000**
	Prop. Spill	-4.57	2.0474	<0.0001	**0.000**
2011	Spill	-4.726	0.0061	<0.0001	**0.000**
	Prop. Spill	-5.5093	3.9044	<0.0001	0.849

Logistic regression analyses of return year 2007 revealed no significant effect of spill volume or spill proportion on the probability of re-ascension (Table 7). Furthermore, goodness of fit tests revealed that the spill volume model lacked fit (i.e., $p < 0.05$), while the spill proportion model had good fit (i.e., $p > 0.05$) (Table 7, Figure 16). It appears that, in 2007, neither spill volume or spill proportion had an effect on re-ascension probability. In fact, according to the models, the probability of re-ascending at MCN in 2007 was in the 0.01 to 0.03, regardless of spill volume or spill proportion (Figure 16).

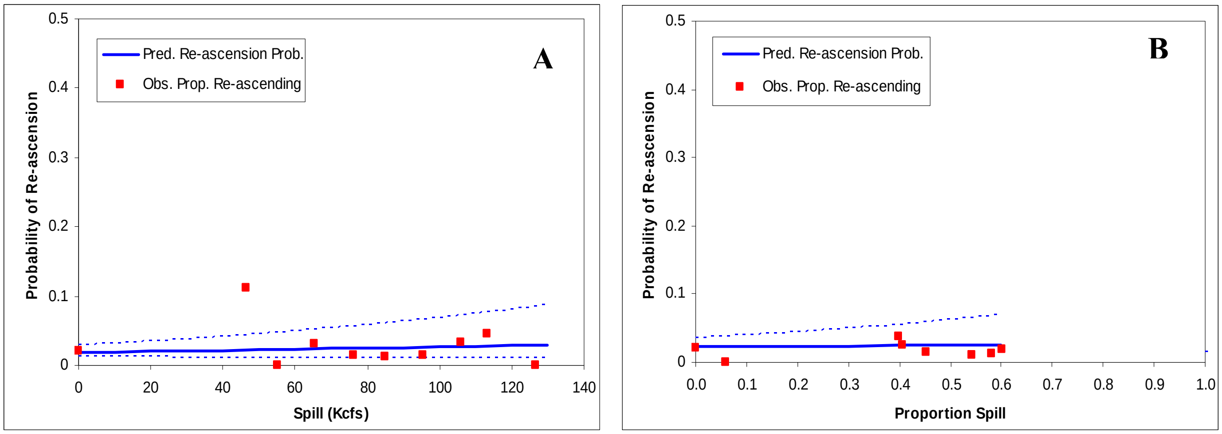

Figure 16. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at MCN in 2007, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

Logistic regression analyses of return year 2008 revealed a significant effect of spill volume and spill proportion on probability of re-ascension (Table 7). In general, as spill volume or spill proportion increased the probability of re-ascension also increased (Figure 17). Furthermore, goodness of fit tests revealed that there was not a significant lack of fit (i.e., p > 0.05) (Table 7, Figure 17). However, even at high spill volumes and high spill proportions, the estimated probability of re-ascension is low. In fact, at the highest spill volume encountered in 2008, which was approximately 250 Kcfs, the predicted probability of re-ascension is only 0.04. Furthermore, at the highest proportion spill observed in 2008, which was approximately 0.6, the predicted probability of re-ascension is only 0.03.

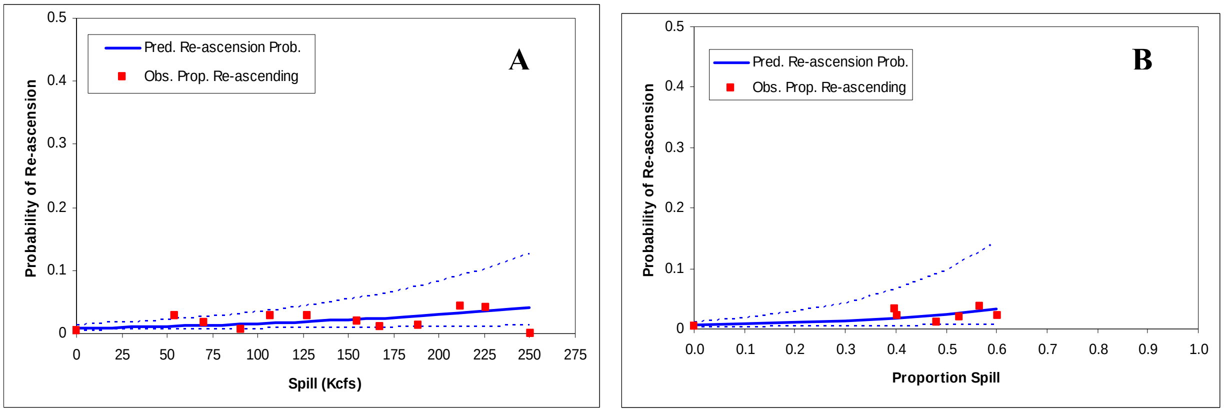

Figure 17. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at MCN in 2008, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

Logistic regression analyses of return year 2009 and 2010 revealed a significant effect of spill volume and spill proportion on probability of re-ascension for in both years (Table 7). In general, as spill volume or spill proportion increased the probability of re-ascension also increased (Figures 18 and 19). However, goodness of fit tests revealed that both models for these return years had a lack of fit (i.e., $p < 0.05$) (Table 7, Figures 18 and 19). This is because the observed data seem to indicate that probability of re-ascension decreases at high spill volumes and high spill proportions, while the logistic models indicate an increasing probability of re-ascension at higher spill volumes and spill proportions (Figures 18 and 19).

As with the results for return years 2007 and 2008, the 2009 and 2010 logistic regression analyses indicate that the predicted probability of re-ascension is low, regardless of the spill volume or spill proportion (Figures 18 and 19). In fact, the highest predicted probability of re-ascension from the models is 0.038 at 180 Kcfs spill in 2009 (Figure 18) and 0.027 at 230 Kcfs in 2010 (Figure 19).

This same pattern is true when considering spill proportion. In 2009, the maximum predicted probability of re-ascension was 0.034 at a spill proportion of 0.6 (Figure 18). For 2010, the highest predicted probability of re-ascension was 0.031 at a spill proportion of 0.55 (Figure 19).

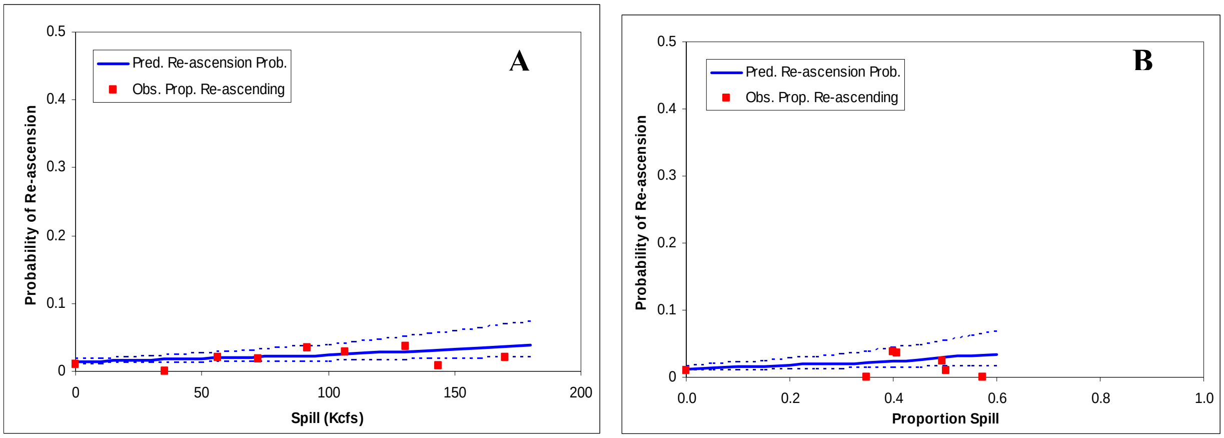

Figure 18. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at MCN in 2009, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

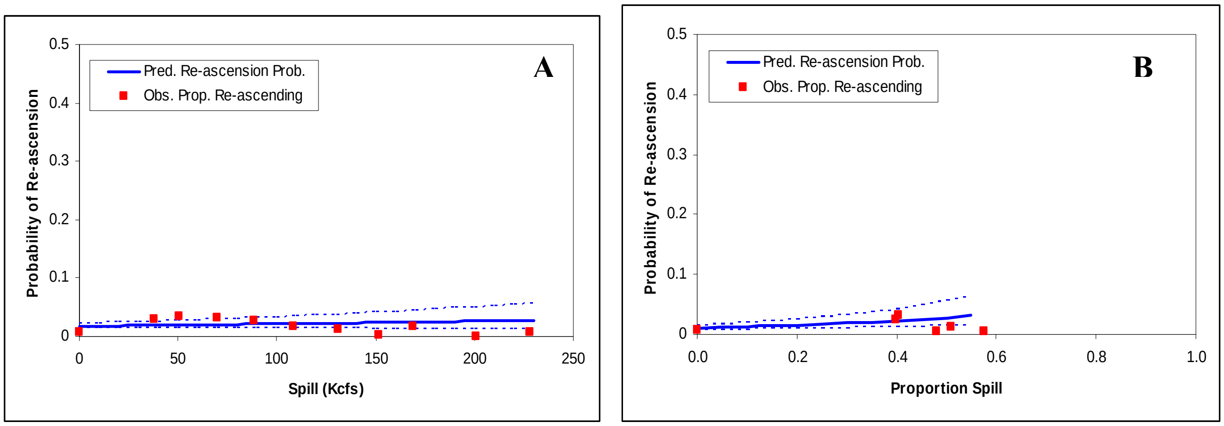

Figure 19. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at MCN in 2010, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

Logistic regression analyses of return year 2011 revealed a significant effect of spill volume and spill proportion on probability of re-ascension (Table 7). In general, as spill volume or spill proportion increased the probability of re-ascension also increased (Figure 20). However, goodness of fit tests revealed a general lack of fit (i.e., p<0.05) for the spill volume model (Table 7, Figure 20). Goodness of fit tests of the spill proportion model indicated no significant lack of fit (i.e., p>0.05) (Table 7, Figure 20). As mentioned above, spill at MCN in 2011 was the highest over the five years in this analysis. Even with these high spill levels, the probability of re-ascension was very small.

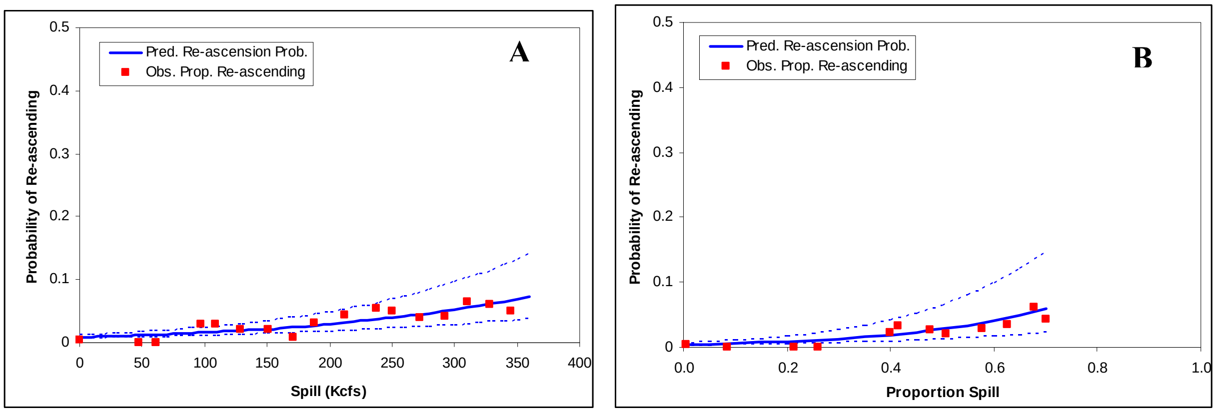

Figure 20. Predicted probability of re-ascension (blue line) and observed proportion re-ascending for PIT-tagged Chinook adults at LGR in 2011, as a function of spill volume (A) and spill proportion (B). Dotted blue lines represent 95% confidence limits.

As with the LGR analyses, it is important to note that the general lack of fit for many of these models warrants caution when using them to make predictions of the probability of re-ascension under particular spill operations.

In summary, the intent of the analysis was to determine if the high flow and spill conditions in 2011 resulted in higher adult fallback. An analysis of adult fallback cannot be conducted based on PIT tag data, but a more limited re-ascension rate analysis can be conducted. The results from the re-ascension rate analyses suggests that there is a relationship between spill (i.e., spill volume and/or spill proportion) and re-ascension rate. However, while a relationship does exist it appears that the overall re-ascension rates for 2011 are within the range of past years at Lower Granite Dam and at McNary Dam.

Sources:

Hosmer, D.W., T. Hosmer, S. Le Cessie, and S. Lemeshow. 1997. A comparison of goodness-of-fit tests for the logistic regression model. Statistics in Medicine 16: 965-980.

Kleinbaum, D.G. and M. Klein. 2010. Logistic Regression: A Self-Learning Text, 3rd Edition. Springer, New York.

FISH PASSAGE CENTER
1827 NE 44th Ave, Suite 240, Portland, OR 97213
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org
e-mail us at fpcstaff@fpc.org

DATA REQUEST FORM

Request Taken By: Brandon Chockley **Date:** 19-July-2011

Data Requested By:
Name: Paul Wagner NOAA/TPAC **Phone:**
Address: **Fax:**
Email:

Data Requested:
Redo fallback/re-ascension analysis @ LGR to investigate effect of spill and add McN.

Data Format: Hardcopy ☐ Text ☐ Excel ☐

Delivery: Mail ☐ Email ☐ Fax ☐ Phone ☐

Comments:

Data Compiled By: **Date:** 18-Oct-2011

Request # 78